THE UNIVERSITY OF ALBERTA

TEACHER REACTION TOWARDS AND PERCEPTION OF CHANGE IN CHEMISTRY 30

by

WILLIAM SOPROVICH

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF SECONDARY EDUCATION

EDMONTON, ALBERTA

MAY, 1966

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Teacher Reaction Towards and Perception of Change in Chemistry 30" submitted by William Soprovich in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

The rapid evolution of scientific knowledge and the obsolescence of science curriculum have produced both a large number of new science programs and a need for change in the science programs of schools. Yet knowledge of the processes of implementation of new curricula and of the views of acceptors of new curricula appears to be uncertain and of relatively recent interest.

The study to be reported arose from the need to determine teacher reaction to and perception of selected aspects of the change process. Specifically, teacher perception of a recent content and textbook change in Chemistry 30 was examined. The problems considered by the study were:

1. Teacher perception of adequacy of content according to the categories of traditional, transitional and supplementary content.
2. Teacher perception of the purposes and adequacy of time devoted to laboratory activities.
3. Teacher perception of selected methods of curriculum change such as teacher experimentation with new courses and multiple texts and the purposes of a "refresher" program.
4. Whether significantly different perceptions of adequacy of content, laboratory and methods of curriculum occurred among subgroups of teachers according to six control variables.

Data was gathered by means of the submission of a questionnaire to all Chemistry 30 teachers under the jurisdiction of the Department of

Education. Returns represented 75.6 per cent of the population. Significant differences among subgroups were determined by use of the chi-square test and the Spearman Rank Correlation Coefficient.

The following conclusions were drawn from the study:

1. A tendency existed among teachers to perceive adequate or decreasing emphasis upon traditional content.
2. Teachers perceived a greater future emphasis upon transitional and supplementary content.
3. Availability of laboratory facilities did not appear to be a factor affecting teacher perception of the time which should be devoted to laboratory activities.
4. Teachers indicated that authorization of experimentation with new courses or a choice of texts would be preferable in an earlier science course than Chemistry 30. Teachers perceived a single authorized text as preferable to a choice of authorized texts.
5. Teachers were overwhelmingly in favor of the use of "refresher" programs previous to the implementation of a content change in Chemistry 30. The ranking of purposes of "refresher" programs by teachers indicated a content orientation on the part of teachers.
6. The control variables did not generally appear to be valid for purposes of categorization of teachers. Some exceptions were:

a) Teachers in the area of specialization of physics-mathematics.

b) Teachers with four or five and ten or more years of experience.

c) Teachers who had attended C. P. E. T. or two or more seminars.

There was some evidence which indicated that a favorable perception of change occurred if the content change was in the area of specialization of the teacher. Further, the possible existence of the view on the part of the teachers that change is essentially content-oriented has important implications in regard to attempted change other than one which is content in nature.

ACKNOWLEDGEMENTS

The writer wishes to express his appreciation to the many persons who assisted in the completion of this study.

In particular, I wish to express my appreciation to the members of my committee:

Dr. M. A. Nay, my supervisor, whose inspiration and insight have been vital factors in its inception and completion;

Dr. W. F. Allen, whose continued interest and attention has encouraged its completion;

Dr. R. R. Rath, whose patient counsel on the statistical procedures and suggestions helped overcome many of the problems in the study;

Professor N. M. Purvis, whose interest and questioning led to better understanding.

Special acknowledgement is also expressed for the efforts made by the many teachers of Chemistry 30 who took the time to complete questionnaires during a busy portion of the school year.

The writer also gratefully acknowledges the encouragement, hours of work, and sacrifice given by his wife.

TABLE OF CONTENTS

CHAPTER PAGE

CHAPTER PAGE

CHAPTER PAGE

LIST OF TABLES

TABLE PAGE

TABLE PAGE

TABLE PAGE

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

I. THE BACKGROUND OF THE STUDY

Need for Curriculum Change in Science Education

> To assail the changes that have unmoored us from the past is futile and in a deep sense, I think is wicked. We need to recognize the change and learn what recourses we have (51).

Many writers in today's journals and periodicals have been concerned with the topic of "knowledge explosion". Although many fields of study had shown a rapid growth in knowledge, the field of science was noted for a near exponential rise in various aspects of scientific knowledge. Riecker accentuated this concept when he stated:

> More scientific and technological discoveries have been made in the past fifteen years than in all previously recorded time. Powerful new insights are being gained into the fundamental structure of major areas of inquiry (53).

The rapid growth in scientific writing was suggested as a major problem to the research scientist by Trieger (66) and Houston (26). The latter noted that some 100,000 magazines produced two million articles a year in the field of science.

The growth in scientific knowledge had become a force for change in science instruction. It was no longer educationally sound to change curriculum in science by adding and subtracting content. This kind of curriculum change developed a course which rapidly became obsolete because of the evolving nature of scientific knowledge. Fitzpatrick suggested this characteristic of science education when he wrote:

> A third notable characteristic of any course of study is that in these days of swift-moving discovery, it can never be static and remain up to date at the same time; constant modification is required to take account of new facts, new concepts and new theories (19).

Thus the nature of science education had shown a tendency to evolve from that of a presentation of factual and technological knowledge to a presentation of major concepts or conceptual schemes of science. Francis S. Chase emphasized this direction in science education when he said:

> In the proposed organizations of curriculum, all pretense of covering the field of knowledge is abandoned, and reliance is placed instead on apprehension of a system of basic concepts and their logical consequences (12).

Thus Showalter (58), Stanhope (63) and Lerner (41) were concerned with interdisciplinary or unifying concepts. They attempted to digress from the traditional compartmentalization of science courses into physics and chemistry, by choosing concepts which may be considered important to both disciplines.

The scientists' former lack of concern for high school science teaching was indicated as one problem of science education by Seaborg, who stated:

> We need not go into all the shortcomings of high school chemical instruction except to emphasize one reason for which most of us carry a heavy share of the blame. I refer to the surprising and persistent lack of interest in high school chemistry. . . on the part of the college professors of chemistry and the professional chemists (57).

The scientists' and college professors' concern for the kinds of content being taught in high school science courses had led to increasing participation in curriculum building by teams of scientists

and teachers. The physical science programs of the P. S. S. C., CHEM Study and C. B. A. Committees were some of the science curricula which had been developed through the team approach. Scott suggested one important reason for continued activity on the part of scientists, when he submitted that:

> . . .every active chemist has good reason to be interested in the trends and developments in the education of chemists. For what is done today is bound to influence. . .the status of the profession of chemistry (54).

Mayor (44) specified a similar reason for cooperative planning among teachers, scientists and school administrators.

The fact that the Russians launched the first man-made satellite in 1957 was sometimes advanced as a major reason for the ferment in science education. However, the need for a major change in science education had been the concern of many science educators previous to this event. Conant, a decade ago, specified an important objective of science education:

> . . .We need a widespread understanding of science in this country, for only thus can science be assimilated into our secular cultural pattern (14).

Seaborg (56) wrote of the liberally educated man who, because of knowledge of his physical environment, had some basis for making intelligent decisions in order to adjust to his environment. Because of its increasing complexity, science placed greater demands upon the scientific literacy of all citizens. Hurd looked to the future as well as the present importance of scientific literacy when he stated:

> The crisis in education has both an immediate and a future aspect. The immediate problem is one of closing the gap between the wealth of scientific achievement and the poverty of scientific literacy in America. . .Breakthroughs in science lead to new horizons, and establish new areas for intellectual conquest which in turn, demand a plan of education to sustain the cycle of achievement (32).

While science had been characterized by a rapidly changing body of knowledge, science education, until the latter portion of the past decade, was characterized by a tendency towards stability. The tendency towards stability in science education was indicated by Williams, who suggested:

> Teachers have received more adequate training in the methods of teaching for assimilation and retention of information than they have in methods of dealing with other important objectives. . . . The relative lack of curriculum materials developed for the expressed purpose of improving the problem-solving abilities of children is likewise disconcerting (71).

Tyler (67) and Merrill (45) also stated that the methods of teaching and learning in most school subjects had been applied to the accumulation of factual knowledge. Science education in Alberta followed a similar pattern to science education in the United States. Hughes' conclusion in regard to stability in science education in Alberta was:

> Revisions were found to be generally of a minor nature involving the addition of a few topics, the selection of a new textbook and the re-emphasis of the importance of sound methodology in the attainment of objectives of science teaching (27).

Hughes also suggested a reason for the slow rate of curriculum change:

> Instead, the tendency has been to wait for change elsewhere, especially in Ontario and the United States, and then to adopt these revisions with only slight modifications (30).

The tendency towards stability in science education had developed an increasingly large gulf between knowledge in science and the concepts

taught in high school science courses. This in turn had led to a re-appraisal and re-emphasis of both the objectives and methods used in science education.

Objectives of science education have been a necessary concern for curriculum-making bodies. However, many expressed objectives of science education did not appear to change radically during extended periods of time. Hurd (31) implied that objectives of science-teaching, as they appeared in educational literature, changed little over the past twenty-five years. Hughes (28) reached similar conclusions in his study of Alberta objectives.

As shown previously, objectives in science teaching had not changed significantly over an extended period of time. In 1895, the Nightingale Committee made the following recommendations to the National Education Association:

> Without laboratory work school chemistry is wholly valueless for the purposes just mentioned. It should be preceded by physics, since chemistry necessarily assumes a knowledge of the physical properties of matter and of the phenomena connected with heat and electricity. . . .The experiments must be performed by each pupil individually. . . .The theories and principles must be presented inductively. They should not be stated as dogmas, or as if they were part of the facts (55).

It appeared that many of the ideas presented by the Committee would be regarded as valid in the present decade. For example, the new studies in the physical sciences, P. S. S. C. physics, CHEM Study, and C. B. A. chemistry, appeared to have concern for some of the methods suggested by the committee. Chase indicated some of the processes used by the new studies in order to achieve the objective of enquiry learning, when he stated:

> The emphasis on laboratory, on investigatory procedures, on the formulation and testing of hypotheses--in short, on the participation by students in a genuine process of scientific enquiry--is probably the most notable feature of the curriculum studies (13).

Carleton (11) and Tyler (68) similarly emphasized the enquiry approach to laboratory experiences as one of the methods of the new physical science courses.

The demand for increased use of the laboratory and the attempt to achieve some learning inductively served to re-define the role of the teacher in these kinds of learning experiences. As indicated earlier, science teaching had tended to emphasize the assimilation of factual knowledge. Laux envisioned a new role of the teacher in science teaching:

> He thus functions in directing student enquiry and in creating an environment wherein learning is maximized. . . .Much of the classroom activity is open-ended, with no set of known directions or answers (40).

Decisions in regard to the amount of direction to be given to students, the amount of background information, and the type of evaluation must be made by the teacher. These decisions in many instances required a new role for the teacher in which he was a guide for learning rather than a disseminator of information.

The growth in scientific knowledge, the lack of achievement of some objectives in science education, and the tendency towards stability in science education led to the present increase in the number of new science curricula. The diffusion of the new science curricula throughout the United States and Canada heralded the possible beginning of change in science education. In 1964, the

National Science Foundation reported the current development of thirty projects in secondary school science (53). Brandwein reported a need for further curriculum development when he stated:

> We need science programs which meet the requirements of four levels of intellectual capacity: slow, moderate and fast groups and gifted groups as well. . .Much remains to be done--and it is well worth emphasizing that we are only at the beginning of twenty years of work (10).

Curriculum Change in Chemistry 30 in Alberta High Schools

Recently, the Alberta Department of Education through the Senior High School Physical Science Sub-Committee and the Senior High School Curriculum Committee, had been involved in a curricular-change. The basic responsibility of the Physical Science Sub-Committee was to make recommendations for curricular-change in physical sciences to the High School Committee. The latter committee was responsible for rejecting, accepting in part or in total the recommendation of the Sub-Committee. The curricular-change, if accepted, was then recommended to the Minister of Education. The final decision remained legally with the Minister of Education. The innovation suggested by the Sub-Committee was a change in content in a Grade Twelve chemistry course, Chemistry 30. The content previously outlined for Chemistry 30 had existed since September 1955. The text used in Chemistry 30 for this period of time was entitled Chemistry for Secondary Schools by Croal, Cooke and Louden*. In the fall of 1963, the teachers were

---

*See Appendix B for a comparison of the textbooks Chemistry and Chemistry for Secondary Schools, p. 174.

made aware of impending change in the content of Chemistry 30 with the addition of a Chemistry 30 Supplement (3) to the existing program of studies. Some content change occurred at this time*. The Physical Science Sub-Committee during the following school-year, sponsored pilot studies in two new Chemistry 30 textbooks with similar content**. Chemistry by Sienko and Plane was recommended for use as a textbook to the High School Committee. The new Program of Studies and the textbook were implemented in Alberta High Schools in the fall of 1964. The laboratory manual Laboratory Exercises in Chemistry 30 (39), was retained for the school year 1964-65.

II. THE PROBLEM TO BE INVESTIGATED

The statements of many educators indicated both a need for change in science education and some reasons for the existence of a wide separation between present scientific knowledge and the kind of science taught in high schools. The change in content in Chemistry 30 attempted to introduce concepts of more recent vintage within the curriculum. Although the centrally-coordinated approach achieved a relatively rapid curriculum change in Alberta schools, differential teacher perception of the need for content change and of the degree to

---

*The topics introduced were: kinetic molecular theory and states of matter, chemical equilibrium, energy in chemical reactions, and the fundamentals of the quantum mechanical atom.

**The textbooks used in the pilot study were: Chemistry-Canadian Edition by Sienko and Plane (McGraw-Hill) and Basic Modern Chemistry by Madras, Hall and Holcombe (McGraw-Hill).

which curriculum change should be implemented may have affected the success of the modifications. In addition, variations in teacher characteristics such as years of training or experience may have been related to variations in teacher perception of adequacy of content, laboratory experiences and other activities in the field of science teaching.

This research will attempt to answer some questions associated with teacher perception of a need for curricular-change in the areas of content, laboratory purpose and use, and selected mechanics of curricular-change. Further, teacher perception of the adequacy of the textbook Chemistry by Sienko and Plane will be examined.

The questions to be considered are:

1. The perception by Alberta teachers of the need for introduction of some new concepts into the Chemistry 30 curriculum.
2. The perception by Alberta teachers of the adequacy of the new textbook in Chemistry 30.
3. The perception by Alberta teachers of the purposes of the laboratory.
4. The relationship between teacher perception of need for change in content and:
   a) Years of experience in Chemistry 30.
   b) Teacher attendance or non-attendance at in-service seminars.
   c) The number of university years of teacher education.

d) The number of university chemistry courses within a teacher's training.

e) The ratio between the number of credits taught in the physical sciences and the total number of credits taught.

f) The area of specialization in teacher training.

Delimitation of the Problem

This study was particularly concerned with the teachers who used the Alberta curriculum in Chemistry 30 and their perceptions in regard to the preceding questions. Although teacher perception of inadequacies in curriculum may be indicative of teacher receptivity to change, no attempt was made to determine the degree of relationship between perception and receptivity. An assumption was made that teacher perception of inadequacies in curriculum may lead to dissatisfaction with curriculum and readiness to change.

Further limitations of the study were:

1. No attempt was made to determine changes in teacher perception which may occur over an extended period of time.
2. Teacher perception of textbook adequacy was limited to criteria selected from Vogel's Spot Check Textbook Evaluation Scale (64).
3. Teacher perception of content change was limited to content within the textbooks used in the previous and the present Chemistry 30 courses. All topics were placed into two

categories*:

a) Traditional content contained topics in both previous and present courses. When compared to the present text, the previous text devoted over 30 percent more pages to each topic.

b) Transitional content contained topics in both previous and present courses. The relative percentage of pages devoted to each topic by the present course in comparison to the previous course was greater than for traditional content.

c) Three additional topics could be used in the development of concepts within the new course and therefore were added as a category of supplementary content.

4. The centrally-coordinated method of curriculum change was not studied.

The population was divided into sub-groups in order to determine the relationship between teacher characteristics and teacher perception of the curriculum change.

The control variables were defined as follows:

1. Years of teaching experience in Chemistry 30. The number or years was not limited to consecutive years of experiences.

---

*For the criteria used to develop the two categories, refer to Appendix B, pp. 172.

2. Teacher attendance or non-attendance at in-service seminars. The seminars were limited to summer sessions which varied in length from two to six weeks. The seminars were concerned with the introduction of new concepts in chemistry.
3. The number of university years of teacher education. This was determined for the teacher by an Evaluation Committee which contained representation from the University of Alberta.
4. The subject area specialization was determined from the indicated major fields of study within a teacher's university training. For example, if a teacher indicated that the first two subject fields were botany and zoology, the subject area was classified as biological science.
5. Science courses in the junior or senior high schools which contained physics or chemistry were defined as physical science and compared to the total credits taught in order to determine the ratio.
6. The number of university chemistry courses in a teacher's training.

Hypotheses

The major hypotheses tested were:

H_1: There are significantly different perceptions of the adequacy of traditional, transitional and supplementary

content in the chemistry program for 1963-64, for 1964-65, and of future emphasis to be placed upon this content among categories of teachers according to:

1. The number of years of university training.
2. The number of university chemistry courses completed.
3. The subject area specialization.
4. The number of years of teaching experience in Chemistry 30.
5. The ratio between credits taught in the physical sciences and the total credits taught.
6. Attendance or non-attendance at in-service seminars.

H_2: There are significantly different perceptions of selected aspects of the text Chemistry by Sienko and Plane and about the effectiveness of selected teaching methods, among categories of teachers according to:

1. The number of years of university training.
2. The number of university chemistry courses completed.
3. The subject area specialization.
4. The number of years of teaching experience in Chemistry 30.
5. The ratio between credits taught in the physical sciences and the total credits taught.
6. Attendance or non-attendance at in-service seminars.

H_3: There are significantly different perceptions of the purposes of, and time to be devoted to, laboratory experiences in Chemistry 30, and time to be devoted to

laboratory experiences in Science 20 among categories of teachers according to:

1. The percentage of time laboratory facilities are available.
2. The number of years of university training.
3. The number of university chemistry courses completed.
4. The subject area specialization.
5. The number of years of teaching experience in Chemistry 30.

H_4: There are significantly different perceptions of selected methods of curricular-change such as curricular-change by teachers, among categories of teachers according to:

1. The number of years of university training.
2. The number of university chemistry courses completed.
3. The subject area specialization.
4. The number of years of teaching experience in Chemistry 30.
5. The ratio between credits taught in the physical sciences and the total credits taught.
6. Attendance or non-attendance at in-service seminars.

A teacher with long experience in teaching Chemistry 30 and a heavy teaching load would be expected to experience difficulty in maintaining knowledge of recent scientific changes and thus would not have perceived inadequacies within the curriculum. A teacher with recent experience in a university chemistry course and an educational background of a large number of chemistry courses would be expected to

develop perceptions of curricular inadequacies.

H_5: There are significantly different perceptions of the purpose of "refresher" programs but no significantly different perceptions of the need for "refresher" programs among categories of teachers according to:

1. The number of years of university training.
2. The number of university chemistry courses completed.
3. The subject area specialization.
4. The number of years of teaching experience in Chemistry 30.
5. The ratio between credits taught in the physical sciences and the total credits taught.
6. Attendance or non-attendance at in-service seminars.

Although teachers had varying backgrounds in their teacher preparation, all teachers were expected to perceive a need for refresher programs because of their awareness of knowledge obsolescence. However, their different backgrounds were expected to affect their perception of the primary purpose of a refresher program.

III. SIGNIFICANCE OF THE STUDY

Obourne and Gatewood (50) suggested a problem in the implementation of innovations in science education, when they stated that too many people do not care whether science programs are up-dated, while others insist on adoption of "modern" curricula, then act as though the revolution was completed with <u>one</u> class using a "modern" course. Campbell and Bunnell indicated another problem which appeared to be developing:

> However, schools in rural areas and serving populations of lower socio-economic status have not benefited as much as the more favored schools with a result of widening the gap that may already exist between them (9).

These and other problems were related to difficulties in the implementation of innovations.

Concern for the study of the process of change and the execution of change processes in education appeared to be of recent interest. Patterson reported in 1950:

> . . .whereas studies of the objectives of chemistry instruction are plentiful, there are few studies which seek to determine ways in which the objectives may be realized or whether they are realized (4).

Miles (48) similarly was concerned with the imbalance between financial support for the development of innovations, and financial support for the study of implementation of innovations. The development of national laboratories, research centres at major universities, and supplementary service centres in the United States (24), denoted increasing concern with this facet of curricular-change. Keppel specified the function of the research centres when he wrote:

> What we seek through them is no mere exercise in curriculum reform or educational upheaval, but a continuing stimulus for change in the American classroom (37).

By determining teacher perception and reaction to content change in Chemistry 30 present and Chemistry 30 future, the purpose of the laboratory in science education, and some mechanics of curricular-change, this research may determine:

1. Receptivity of teachers to curricular-change in content, laboratory and mechanics of change.
2. Teacher perceptions and preferences in curricular-change.

3. Factors which will aid in the promotion of teacher receptivity and hence may aid curricular-change.

If continued on a longitudinal basis, the study may provide insight in regard to:

1. The effect of in-service training upon teacher perception of curricular-change.
2. The effect of teacher experience with the new program upon teacher perception of curricular-change.
3. Methods which will aid in the implementation of curricular-change.
4. The evolution of teacher perception of adequacy of content change.

IV. DEFINITION OF TERMS

In general, the meaning of each of the following terms was indicated where it was first used in the study, but, for easy reference, the following list was presented at this point.

Area of Specialization referred to the subject areas in which a teacher specialized at university. This consisted of the two areas ranked as first and second by the teacher.

Chemistry 30 Teacher referred to a teacher who was teaching at least one class of the Alberta Chemistry 30 curriculum during the school year 1964-65.

Future Course referred to teacher perception of the emphasis which may be placed upon selected topics in Chemistry 30 within five years.

In-service Seminars referred to summer session programs sponsored by the University of Alberta or the Science Council of Alberta. The sessions varied in length from two to six weeks and were provided for teachers in the Alberta teaching force. The seminars were concerned with the presentation of new concepts in chemistry.

New Course referred to the Chemistry 30 curriculum introduced into high schools under the jurisdiction of the Alberta Department of Education during the 1964-65 school year (text by Sienko and Plane).

Old Course referred to the Chemistry 30 curriculum in high schools under the jurisdiction of the Alberta Department of Education during the 1962-63 school year (text by Croale et al).

Population referred to all Chemistry 30 teachers.

Ratio of Physical Science Credits referred to the ratio between the number of physical science credits taught (physics and/or chemistry) and the total number of credits taught by a teacher.

Supplementary Content referred to a category which contained the topics of orbital overlap, hybridization of orbitals, and delocalized electrons. The topics were not in the Program of Studies but could be used in developing some aspects of the present course.

Traditional Content referred to a category which contained topics in both previous and present Chemistry 30 courses. When compared to the present text, the previous text devoted over 30 per cent more pages to the topic.

Transitional Content referred to a category which contained

topics in both previous and present courses. The relative percentage of pages devoted to each topic by the present course in comparison to the previous course was greater than for traditional content.

V. PREVIEW OF THE STUDY

The present chapter is an introduction to and preview of the study. Chapter II consists of a review of literature that is related to the study. This includes literature related to a theory of change and the variables used for the categorization of teachers. Chapter III includes a detailed description of the design of the experiment and the statistical procedures used in analyzing the data.

Related areas of study require the presentation of statistical analyses within three chapters. Chapter IV presents teacher perception of content in old, new and a future course. Chapter V presents analyses of data related to the present textbook, the laboratory, and methods of instruction. Chapter VI contains analyses of data related to methods of curriculum change. Chapter VII includes a summary of the results of the investigation, conclusions, and implications for further research.

CHAPTER II

REVIEW OF RELATED LITERATURE

The increased number of new science programs focused attention upon the process of implementation of new curricula and the position of teachers within this process. Increased attention to this aspect of curriculum change led to an increase in research upon the many aspects of implementation and the development of models or theories within which curriculum change may be examined. Thus the first part of this chapter was devoted to a theory of the change process and relation of the change in the Alberta Chemistry 30 curriculum to this theory.

The second part of this chapter was devoted to literature which related the position of the teacher and teacher characteristics to the change process. This included teacher receptivity and perception of change. One of the methods of up-dating teacher knowledge and influencing teachers presently in service was the summer institute. This was examined in terms of the kinds of teacher applicants for N. S. F. sponsored institutes and the possible effects of the institutes upon knowledge of science. Finally, the textbook, a major instrument of curriculum change and an important teaching aid in high school chemistry, was examined.

A Theory of the Change Process

One of the characteristics of an institution such as the school or school system was its tendency to remain stable and to

resist the introduction of educational innovation. Bushnell, in writing about rate of diffusion of educational innovation, concluded:

> We can say that it probably takes something less than twenty years for a good educational innovation to be introduced into half of the public schools today. This is a considerable improvement over the forty-one years it used to take to reach fifty per cent diffusion. But there's a long way to go. School people--teachers in particular--must become aware that sensitivity to needs, willingness to experiment to find solutions and conscious effort to promote the use of good educational ideas are essential in reducing the present time lag in education (8).

That curriculum change was also slow in Alberta was indicated by Hughes, who wrote:

> Other evidence of inertia has been the long intervals of time which have elapsed between major curriculum revisions and also, between new textbook authorizations (29).

This was illustrated by the Introductory Remarks in a 1960 Departmental Bulletin (16) on changes in Science 10*. The Bulletin implied that science teachers would find no new science concepts had been introduced, but that a re-arrangement of material which included some concepts formerly in Grades Eleven and Twelve, had occurred. Essentially, the new Science 10 program replaced some topics in geology, meteorology and astronomy with topics from chemistry and physics. Inertia on the part of the school or school system may have been one factor which affected the success or failure of innovations. Although a time-lag may be necessary and perhaps important in order to allow the system to sift the weak innovation from the strong, the demands created by rapid obsolescence of knowledge, made imperative a

---

*Science 10 is a physical science program for Grade Ten students in a Senior Matriculation program.

more rapid rate of diffusion for innovations.

A model of strategies for curriculum change was developed by Miles (47). His model contained four states which may occur prior to the adoption of an innovation. The states may be defined as:

1. Design - the innovation is invented, discovered, made up of whole cloth, produced by research and developmental operations, etc.
2. Awareness-interest - the potential consumers of the innovation, that is, the members of the target system, become aware of the existence of the designed innovation, become interested in it, and seek information about its characteristics.
3. Evaluation - the consumers perform a kind of mental trial of the innovation, and form pro-con opinions about its efficiency in accomplishing system goals; evaluate its feasibility and its cost.
4. Trial - the target system engages in a (usually) small-scale trial of the innovation, in order to assess its consequences. If these are favorable, the innovation tends to be adopted and the strategy is complete.

Miles further indicated that the initiator of a strategy for change, or change-agent, may be either the target system or systems external to the environment.

Miles' model placed emphasis upon the role played by the potential consumers of the innovation. He also appeared to assume a

high degree of potentiality for change on the part of the consumer. Whether this assumption was valid was unknown. The relative effect of the external change agent and the consumer upon change required further study. MacKenzie suggested:

> . . .the potential usefulness of policies to guide the curricular-change process within a system, as well as to help regulate and manage the influences coming from agents outside of the system, has received scant attention. Both of these areas, but particularly the latter, hold much promise for the development of new and much-needed mechanisms to help control the curricular-change process (43).

The major change agent in the diffusion of curricular-change in Chemistry 30 in Alberta was the Physical Science Sub-Committee. A change-agent was defined as an outside agent who observes the need for change in a particular direction and takes the initiative in establishing a helping relationship with that system (42). The strategies for change initiated by the Sub-Committee may be applied to a portion of Miles' model. The change agent designed a new curriculum, evaluated the relative merits of the textbooks, and chose the textbook. The change agent initiated awareness of impending change by means of issuing a Chemistry 30 Supplement in the previous year, and accepted a curricular-change on behalf of the consumers. The centrally-coordinated approach had the obvious advantage of rapid diffusion of a content change. The strategy of change employed by the Sub-Committee, however, was different from Miles' model in the following ways:

1. The consumers of the innovation were limited in their ability to reject an innovation, either previous to or

after a trial period. However, provision was made for communication of the consumers' reactions to change in content through High School Inspectors, Teachers' Conventions and other channels. This procedure provided for the possibility of further revision in the curriculum.

2. The large target system involved in the diffusion of an innovation presented a communication problem during the awareness-interest stage of the change strategy. Thus awareness and interest on the part of the consumers may have been limited during this portion of the strategy.
3. The strategies used may have placed less emphasis upon the potentiality for change on the part of the consumer.
4. The Physical Science Sub-Committee was not a pure change-agent within Miles' definition. The Sub-Committee selected content and a textbook rather than designed a curriculum.

The Teacher in Curriculum Change and Barriers to Change

M. L. Watts, when speaking about the relationship between curriculum guides and the curriculum in schools, stated:

> Of course, it is recognized that, as in some marriages, the relationship may at times be discordant or distant; but at present there is no legal provision for separation or divorce, even though it is known there exist some cases of adulteration on the part of the curriculum (70).

Van Til further developed this concept when he suggested:

> . . .that effective curriculum change does not come about simply through edict or by publication of materials alone, as "common

> sense" glibly assumes. Changing the curriculum necessitates changing the people who have relationships to the actual learning experiences of children and youth (69).

The teacher's views of his own abilities, the philosophy of the school, the abilities of his students and other factors affected his views of the curriculum. The content within some courses may be partially standardized through external examinations; however, the teacher determined the depth or lack of depth of study undertaken by the students under his jurisdiction. Thus the final curricular-change appeared to be dependent upon the teacher.

If the final curricular-change was dependent upon the teacher, knowledge of factors which impinged upon a teacher's acceptance of change became necessary. Studies of factors related to resistance to change and teacher characteristics, in addition to the effect of teacher involvement in change upon readiness to change, needed to be explored. Dempsey (15) studied teachers' judgments of barriers to change in relation to the factor of individual readiness to change. Dempsey's barriers to change were internal barriers of self and external barriers of time, parents, school policy, school personnel and others. His conclusions were:

1. Teachers who are ready to change see fewer barriers to curriculum change.
2. Younger teachers see fewer barriers to change than older teachers.
3. Teachers with little teaching experience perceive fewer barriers to change than teachers with more teaching experience.

4. Teachers with little teaching experience are more likely to attempt job-related change than those with more teaching experience.

5. Teachers with Master's degrees perceive fewer barriers to change than those without Master's degrees.

Eichholtz (17), in his study of rejection classifications for newer educational media, concluded that rejection of the media did not seem to be related to teaching experience or the grade taught. He stated that lack of data may have prevented substantiation of his stages of rejection. Kelley (36), in his studyof elementary teachers' attitudes toward audio-visual materials reported a significant relationship between attitudes and teacher training. The literature appeared to present both conflicting evidence and a lack of sufficient evidence of the factors to be studied. More studies in depth of the factors related to resistance to change appeared to be necessary.

The importance of the teacher in the implementation of curriculum change had received increasing attention in educational literature. Gilchrist suggested that:

> There is a growing tendency to recognize teachers as key persons in curriculum development rather than merely recipients of the curriculum thinking of others (20).

Hutchinson indicated a possible relationship between external change-agents and teachers when he stated:

> Change is often resisted when developed by an outside agency and recommended to an administrator. . .The person requested to implement the innovation does not see all the possibilities it offers (34).

Mort implied the importance of teacher involvement in curriculum change when he specified that:

> The studies of adaptability indicate that vastly more must be done to involve those who must change if we are to adapt and to involve them so fully that the participants' conception of the enterprise and his participation in it will be enhanced (49).

Huesner suggested not only the importance of teacher involvement but also some limitations upon his role:

> Teacher participation does not necessarily result in increased utilization unless satisfactory conditions are present relative to such factors as recognition, time, role and organization. The degree of readiness in terms of their felt needs, as well as their background in the subject and in learning theory, appears to be an indicator of where to begin (25).

Kniseley (38) suggested that teacher amenability to change was affected by a broad knowledge of curriculum: knowledge about the variety of subjects, skills and understandings dealt with, the organizational operation, and services of the American school.

Friedrich (18) studied teachers' feelings of adequacy and attitudes towards thirty-nine contemporary topics in high school chemistry. Friedrich's conclusions were:

1. A highly significant relationship existed between feelings of adequacy and teachers' attitudes toward inclusion of the topics in a high school chemistry course.
2. No significant relationship appeared to exist between favorable attitudes towards the topics and the teachers' subject matter major, the number of semester hours of credit earned and years of teaching experience.
3. A significant relationship occurred between participation

in N. S. F. Institutes and attitudes toward six of the topics.

Friedrich further indicated that the non-linear relationship between teacher attitudes and increasing years of experience warranted further investigation.

The preceding literature cited indicated the presence of two major areas of study related to a teacher's amenability to curriculum change. The areas were the teacher's background in terms of involvement in change, felt needs, subject and learning theory, and the external factors within the school and community. Miel (46) associated "general receptivity to change" with the intensity of dissatisfaction present in the population. She indicated that an increase in dissatisfaction correlated positively with an increase in receptivity. This implied an existing perception of a need for change because of perceived inadequacies in the environment of the population. Thus perception of inadequacies in the curriculum may have led to an increase in dissatisfaction with the curriculum within the teacher. Action or lack of action in curriculum change by teachers would appear to be affected by the intensity of external factors in comparison to the intensity of the dissatisfaction present in the population.

Although research existed on the rate of diffusion of innovations, little research appeared in relation to the changes which may occur in teacher acceptance over a period of time. Brickell visited thirty-five school systems in his analysis of teacher reaction to change, and concluded:

> Faculty members ordinarily begin to prefer new methods within four months to a year after a novel program has been introduced, regardless of their early reactions. It seems reasonable to believe that after teachers learn how to do the job they feel competent and secure (5).

Brickell's conclusion implied that curricular-change may be readily promoted from a centrally-coordinated agent with the expectation that resistance to change would become negligible after an initial period of re-adjustment. Application of Brickell's conclusion to the change process in Alberta was dangerous because of the probable differences among the groups. However, the importance of the provision of aid for the teacher-consumers in order to promote a more rapid and effective change appeared to be further validated.

The Effect of Summer Institutes Upon Teacher Training

The summer institute had been considered as one method for the up-dating of teacher background. The impetus given to this method of teacher training by the N. S. F. carried with it a necessity to examine the effects of the institute upon both teachers' backgrounds and teachers' attitudes towards new concepts in chemistry. The N. S. F. sponsored a study in regard to the differences between applicants and non-applicants. Orr and Young (52) discovered that the non-applicants more often taught in rural rather than in urban school systems and in smaller schools rather than in larger ones. The non-applicant also tended to be less well trained in science than the applicant; he was less satisfied with the job; and he derived relatively less satisfaction from his subject matter activities. An indication of the effect of external factors was illustrated by the report that

the non-applicants tended to feel that the parents, students and community surrounding them were comparatively less favorable toward education and science. Parker (7) examined the results of participation by science teachers in N. S. F. summer institutes. The returns from 162 teachers and 137 principals represented 50 per cent of the total group to whom questionnaires were sent. More than 90 per cent of the teacher-participants and their principals reported an up-dating of teaching ability and enthusiasm. The teachers cited increased scientific knowledge and better use of laboratory equipment as the chief gains. Gruber (21) studied nine N. S. F. academic year institutes to determine whether, as a result of their institute experience, the participants were oriented toward the teaching of science more as a way of thought and inquiry than as a set of established facts and principles. The study showed that 25 per cent showed strong and 60 per cent showed negligible interest in this approach to science. Gruber further concluded:

> . . .high school teachers generally approach science teaching as a matter of conveying science as established facts and doctrines; training programs stressing passive-receptive teaching methods do little to alter this approach; training programs stressing active participation by the Fellows may lead to an approach to science teaching in which science is treated as a way of thought.

The limited research appeared to indicate that teachers who were oriented toward improvement of their background were both the applicants for and the receivers of additional training. The major value of institutes, up-dating of knowledge, may have provided for the removal of a teacher's fear of a content change. However, in order to modify teacher perception of curriculum change or approaches

to science teaching, evidence indicated a major revision in the kind of institute provided.

The Chemistry Textbook

The textbook appeared to be a major resource in the teaching of chemistry. Thus knowledge of content changes and reading levels in textbooks was an important part of curriculum. Harriman (22) studied the inclusion of modern chemistry in a number of secondary school chemistry textbooks by the use of a formula which included the number of pages devoted to a particular topic. He found that the textbooks lacked materials considered important by chemists and failed to include materials of a more modern nature. Jacobson (35) compared the reading difficulty of fourteen textbooks in use in high schools of Minnesota. The formula used by Jacobson included the variables of average sentence length, average number of syllables in a word, concentration of mathematical terms and the concentration of words not found in Thorndike's and Powers' word lists. Jacobson concluded that the textbooks General Chemistry by Snead et al and Chemistry by Sienko and Plane were both significantly more difficult than the remaining twelve textbooks evaluated.

The ferment in education apparently forced researchers in education to examine more closely the problem of implementation of new programs. Research had attempted to clarify the role of teachers in the process of change and to determine the characteristics of teachers which may affect their readiness to change. The related

literature appeared to support a number of conclusions associated with curriculum change:

1. Teachers with less teaching experience or with Master's degrees perceived fewer barriers to change than teachers with more teaching experience or less training.
2. Favorable attitudes toward the inclusion of contemporary topics in a chemistry course appeared to be related to teacher characteristics of training and experience.
3. Teachers appeared to accept change within four months to a year after the introduction of a new program. Thus a decrease in resistance to a curricular-innovation may be related to teacher experience with and competency in the new program.
4. Summer seminars essentially up-dated teacher knowledge. A change in the format of seminars may be needed to change teacher perception of curricular-change and of methods of science teaching.
5. Applicants for summer seminars appeared to be more favorable toward science education and perceived fewer external barriers toward education and science.
6. As with curriculum change, chemistry texts tended to be lacking in materials of a more modern nature.

CHAPTER III

METHOD OF INVESTIGATION AND METHODS OF ANALYSIS OF DATA

I. METHOD OF INVESTIGATION

The Instrument

A questionnaire (see pp.150-63 of Appendix A) containing 147 selected items was used to obtain data relating to teacher perception of change in Chemistry 30. The areas selected for exploration by means of the questionnaire were:

1. General information about teachers and their schools for the purpose of comparison of teachers. This included years of teaching experience with Chemistry 30 courses, years of university training, in-service seminar attendance, physical science and total credits taught, number of university chemistry courses, and area of specialization.
2. The area of curriculum change, which included:
   a) Evaluation by teachers of the emphasis placed on selected topics in the Chemistry 30 courses of 1963-64 (old course) and 1964-65 (new course). In addition, teachers were requested to indicate their perception of the probable degree of emphasis to be placed on the selected topics in future Chemistry 30 courses.
   b) Evaluation by teachers of the new textbook Chemistry by Sienko and Plane. Criteria used in the evaluation of the textbook were:

(1) General evaluative criteria selected from Vogel's Spot Check Textbook Evaluation Scale (64). A spot check scale of this nature attempted to introduce greater objectivity to the comparison of textbooks in science. A limitation placed upon this type of analysis is that the author of the scale must choose criteria out of a large number of factors which may be considered in textbook evaluation. Therefore, criteria recommended by Curtis (65) in regard to vocabulary was added to the criteria selected from Vogel. This provided both for a limited evaluation of and reaction to the present textbook in Chemistry 30.

(2) Evaluation by teachers of the adequacy of the text in relation to the selected topics of Chemistry 30.

c) Evaluation by teachers of the difficulty encountered by students with selected topics in the Chemistry 30 course of 1964-65.

3. Methods of instruction, which included:

a) Evaluation by teachers of the purposes of laboratory activities in Chemistry 30.

b) Evaluation by teachers of selected teaching methods.

4. Present practices in the mechanics of curriculum development and change.

Pretest of the Questionnaire

The first questionnaire of 139 items was pretested by the submission of the questionnaire to thirty-four Chemistry 30 teachers. This sample comprised 10.2 per cent of all Chemistry 30 teachers in Alberta and the Northwest Territories. The thirty-four teachers were chosen on the basis of geographical distribution (see p.164 of Appendix A) throughout the province of Alberta. Superintendents of Counties, School Divisions and School Districts were contacted by letter the week of March 16th, 1965. The questionnaires and instruction sheets were submitted to the selected Chemistry 30 teachers through the office of the Principal on April 5th. A letter of reminder to the teachers was submitted on April 14th. Twenty-nine of thirty-four questionnaires were returned which represented an 85.3 per cent response.

The pilot study was conducted in order to evaluate the 139 items on the questionnaire. The items were tested for the percentage of response, ambiguity of terminology and structure, and the general structuring of items within the questionnaire. On the basis of the response, one item was removed and nine items were added to the questionnaire. Thus the final questionnaire included 147 items.

Collection of Data

Examination of the Principals' Form A cards at the Department of Education revealed a total population of 333 Chemistry 30 teachers. A Chemistry 30 teacher was defined as a teacher who was teaching Chemistry 30 under the jurisdiction of the Department of Education during the year 1964-65. Changes in the organization of some schools reduced the total

population to 328*.

A letter requesting permission to distribute the revised questionnaires was sent on May 11th to all Superintendents not previously contacted. The revised questionnaire was submitted to the total population on May 22nd. The respondents were provided with stamped, addressed reply envelopes in order to provide anonymity to the returns. A letter of reminder was sent to the total population on June 7th and a final letter of reminder was sent on June 24th (see p. 168 of Appendix A).

Returns

The teachers returned 202 questionnaires previous to June 13th, 44 between June 13th and June 29th, and 11 after June 29th for a total of 257. The second and third groups of questionnaires were considered to be received after the mailing of reminder letters. Of the questionnaires received, nine were incomplete and were rejected, leaving a total of 248. The returns from the teachers equaled 75.6 per cent of the total population.

Population Variables Used in the Study

In order to determine significant differences in teacher perception of adequacy of content, of textbook and other aspects of change, the respondents were placed into sub-groups within six population variables. Whenever possible, sub-groups which contained less than twenty respondents were combined in order to increase the power of the

---

*Three schools had converted to Correspondence School and two teachers were travelling teachers who taught Chemistry 30 at two different schools.

statistical tests used in the study. Thus a variation occurred within the scales used for years of training and experience. Because of the existence of major differences among some of the sub-groups within the variable of attendance at seminars, no adjustment was made in some assigned categories. The categories, numbers and percentages of respondents within each sub-group were shown in Table I.

II. ORGANIZATION OF DATA

The large number of items within the questionnaire and the high percentage of returns necessitated data processing by means of the IBM 7040 computer. The computer provided one-way tabulation of data with the use of a Fortran program. All questionnaires were coded in order to prepare them for punch-cards. For data within the matrix of the questionnaire, the cards were sorted by means of a card sorting machine in order to provide tabulations for groups and sub-groups. The computer provided chi-square values for the remaining data according to sub-groups.

III. METHODS OF ANALYSIS OF DATA

Associated with every statistical test is a model and a measurement requirement; the test is valid under certain conditions, and the model and the measurement requirements specify those conditions. Sometimes we are able to test whether the conditions of a particular statistical model are met, but more often we have to assume that they are met (3). The parametric tests tended to contain the most extensive or strongest assumptions and thus may be used to arrive at more specific conclusions. Two basic assumptions underlying parametric tests were:

TABLE I

NUMBERS AND PERCENTAGES OF RESPONDENTS AND NON-RESPONDENTS WITHIN THE CATEGORIES OF THE CONTROL VARIABLES

Years of Training

	Number	Percentage of Total Group
3 or less	24	9.7
4	109	44.0
5 or more	115	46.3
Non-respondents	0	0.0
Totals	248	100

Number of University Chemistry Courses

0 - 1	52	21.0
2 - 3	108	43.5
4 - 5	53	21.4
6 or more	20	8.0
Non-respondents	15	6.1
Totals	248	100

TABLE I (continued)

Area of Specialization

Chemistry - Physics	45	18.2
Physics - Mathematics	42	16.9
Chemistry - Mathematics	72	29.0
Biological Sciences	34	13.7
Humanities	39	15.7
Non-respondents	16	6.5
Totals	248	100

Years of Experience with Chemistry 30

0 - 1	57	23.0
2 - 3	57	23.0
4 - 5	38	15.3
6 - 9	34	13.7
10 or more	62	25.0
Non-respondents	0	0.0
Totals	248	100

TABLE I (continued)

Ratio of Physical Science Credits

Less than 1/4	32	12.9
Between 1/4 and 1/2	82	33.1
Between 1/2 and 3/4	58	23.4
More than 3/4	73	29.4
Non-respondents	3	1.2
Totals	248	100

Attendance or Non-attendance at Seminars

Non-attendance	120	48.4
Chemistry 330	10	4.0
Continuing Professional Education for Teachers (CPET)	49	19.8
Science Council Seminar	56	22.6
2 or more seminars	13	5.2
Non-respondents	0	0.0
Totals	248	100

1. The observations must be drawn from normally distributed populations.

2. The populations must have the same variance.

The use of subgroups with a small number of respondents tended to make the assumptions of normally distributed populations and variance invalid. Therefore, the methods of nonparametric statistics were used in the analysis of data. Nonparametric tests made fewer assumptions and led to more general conclusions. They also did not have the power of equivalent parametric tests; however, the use of the total population as a sample and the relatively high returns increased the power of any nonparametric tests used in the analysis of data (59).

The large amount of data to be analyzed necessitated two basic procedures. Data which were considered as not directly relating to the variables under study were tabulated and reported in this form. Secondly, two kinds of data, nominal and ordinal, were available from the questionnaire. Nominal data involved the classification of data into mutually exclusive subclasses wherein the responses within a subclass were equivalent to each other. Computation of chi-square values was used to test the existence of significant differences between observed and expected numbers of responses falling within each category. Ordinal data required that categories be mutually exclusive and also had a relative standing to each other. For example, one category of responses may have designated that an item was more difficult whereas another category designated the item as less difficult (60). Calculation of medians and the Spearman r_s (rho) were used to analyze ordinal data.

Use of Chi-square

In problems involving nominal data, the data were appropriately cast into contingency tables of equivalent size and the probability distribution calculated by the method of chi-square. Expected frequency of response was calculated from marginal frequencies of the contingency tables. The probability value for p has been reported in cases where p was considered to be significant. The p values were cast into tables and the resulting interpretation was based on the value of p. A value of p less than .01 ($p < .01$) was interpreted as very significant; that is, significant differences existed between or among the sub-groups. A degree of significance was implied by a value of p between .05 and .01 ($.01 < p < .05$). A value of p more than .05 was interpreted as nonsignificant. This procedure was chosen in order to reduce the possibility of an α (Type I) error; that is, the hypothesis was rejected when in fact it was true (61).

Use of the Median and Spearman r_s (rho)

A number of items within the questionnaire required a ranking of comparable parts of the item. Where interval relations of this kind occurred, the data were tested statistically by the determination of medians in order to determine the relative ranks of items. The significance of differences in ranking was determined from the calculation of the Spearman Rank Correlation Coefficient. The conditions which must be satisfied before these techniques can be applied were taken into consideration, and in the opinion of the investigator, were considered to be satisfactorily fulfilled. The median formula used in the investigation was:

$$Mdn. = l + \left(\frac{\frac{n}{2} - \sum f_b}{fw} \right) i$$

l = the lower limit of the interval containing the median.

n = the total number of scores.

$\sum f_b$ = the sum of the frequencies below the interval containing the median.

fw = the frequency or number of scores within the interval containing the median.

i = the size of the interval.

The class interval, i, in all cases, was equivalent to one (16).

The formula used to calculate rho was (62):

$$r_s = 1 - \frac{\sum_{i=1}^{N} di^2}{N^3 - N}$$

The difference between the ranks assigned to an item by two groups of teachers is represented by di. The number of items ranked by the two groups is represented by N. Tied observations tended to inflate the value of rho and thus increased the possibility of acceptance of correlation where none may exist. However, the effect of tied observations on rho tended to be negligible if the proportion of ties was low. Interpretations of correlations were made on the same basis of probability as in the case of the chi-square method.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA PERTAINING TO CONTENT CHANGE

I. INTRODUCTION

The data obtained in this study was categorized into three areas:

1. The content in Chemistry 30.
2. Methods of instruction, the purposes of the laboratory in Chemistry 30, and evaluation of the textbook according to criteria selected from Vogel's Spot Check Textbook Evaluation Scale (64).
3. Curriculum development and mechanics of curriculum change.

The analysis and interpretation of data is placed into three consecutive chapters. Teacher perception of content in the old, new and future Chemistry 30 courses is included in the present chapter.

In order to analyze data pertaining to teacher perception of content in the Chemistry 30 courses, the eighteen topics within the chemistry content were classified into three categories.

The topics within each category* were:

1. Traditional content
   a) Chemistry of the elements.
   b) Chemical technology.
   c) Atomic structure (Bohr atom).
   d) Bonding (Bohr atom).

---

*Cf. p. 11.

2. Transitional content

   a) Organic.

   b) Chemical calculations.

   c) Atomic structure (orbitals).

   d) Molecular structure.

   e) Crystal formation.

   f) Solutions.

   g) Oxidation - reduction.

   h) Electrochemistry.

   i) Acids and bases.

   j) Kinetic - molecular theory.

   k) Scientific methods.

3. Supplementary content

   a) Orbital overlap (σ and π bonds).

   b) Hybridization of orbitals.

   c) Delocalized electrons.

For each category, a summation of teacher perception of the adequacy of the topics within old, new and future courses was made.

Analysis of perception of adequacy of content among or between subgroups of teachers required presentation of data by means of two tables for each teacher characteristic. The first table shows the number and percentage response by each subgroup within the teacher characteristic. The response is reported accurately in percentages rounded to the nearest tenth of one per cent. The data within this table shows:

1. Teacher response to adequacy of emphasis upon traditional, transitional and supplementary course content.
2. Similarities and differences in teacher perceptions among subgroups according to the following teacher parameters:
   a) Years of training.
   b) Number of university chemistry courses.
   c) Area of specialization.
   d) Teaching experience with Chemistry 30.
   e) Ratio of physical science to total credits taught.
   f) Attendance or non-attendance at seminars.
3. Trends in teacher perceptions of traditional, transitional and supplementary content emphasis in the old, new, and future courses in Chemistry 30.

In order to show the trend occurring within the population which responded to the questionnaire, the table related to the teacher characteristic of years of training includes a summation of responses to the adequacy of content.

The chi-square test was used to determine differences between subgroups of teachers and was summarized in the second table concerned with each teacher characteristic. Probability values of .05 or less were reported in the table and were used as a basis for comparison of the differences existing between or among subgroups.

II. TEACHER PERCEPTION OF ADEQUACY OF EMPHASIS UPON TRADITIONAL, TRANSITIONAL AND SUPPLEMENTARY CONTENT IN CHEMISTRY 30

Teacher cognizance of the adequacy of emphasis upon traditional, transitional, and supplementary content within the old, new, and future courses is shown in Table II.

Examination of the response of the total group of Chemistry 30 teachers indicated the following:

1. An equivalent percentage of teachers responded that there was too little or adequate content in the old course; three out of four indicated adequate emphasis in the present course; and three out of four responded that equal or less emphasis would be placed upon traditional content in the future course.
2. Three out of four teachers indicated that there was too little emphasis upon transitional content in the old course and adequate emphasis in the present course. Ninety-five out of one-hundred indicated equal or more emphasis would be placed upon this content in a future course. Thirty-seven of the latter group indicated more emphasis.
3. Ninety-five out of one-hundred teachers indicated too little emphasis in the old course, sixty out of one-hundred indicated too little emphasis in the present course; and sixty-four out of one-hundred indicated greater emphasis would be placed upon supplementary content in a future course.

The trend showed that teachers perceived a decreasing emphasis

upon traditional content and an increasing emphasis upon transitional and supplementary content. These teachers appeared to discern content changes which would place greater emphasis upon topics such as atomic structure (orbitals), molecular structure, organic chemistry, and a decreasing emphasis upon traditional content. This was further indicated by the response to supplementary content. Greater emphasis in the future upon the topics of orbital overlap and the hybridization of orbitals was perceived by 72 per cent of the teachers. Thus teachers appeared to perceive changes occurring within the area of the atomic theory and atomic or molecular structure.

Variations in teacher percentage responses to topics within a group limited the interpretations which could be made in regard to the broad groups of traditional and transitional content. This was illustrated by teacher response to the topics of chemical technology and atomic structure (Bohr atom) which were placed within traditional content. A greater relative percentage of teachers perceived a future decrease in the use of the topic of the Bohr atom as compared to chemical technology, whereas a greater relative percentage of teachers perceived a greater emphasis upon chemical technology than upon the Bohr atom.

III. TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO YEARS OF TRAINING

The response of sub-groups in terms of numbers and percentages is shown in Table II. Significant differences in the adequacy of perception of content according to sub-groups is shown in Table III.

Traditional Content

Significant differences occurred among teachers with three or less years of experience and other sub-groups in their perception of course emphasis according to Table III. The difference existed in their perceptions of content in the old and future Chemistry 30 courses. No significant differences occurred between subgroups with four years and five or more years of training.

Although no significant differences appeared among subgroups in their perception of traditional content in the present course, a relationship between years of training and perception of adequacy of content is show by Table II. In comparison to other subgroups, teachers with three or less years of training give the greatest percentage response to:

1. Too little emphasis on traditional content within the old course.
2. Adequate emphasis on content within the new course.
3. Equal emphasis on content in a future course.

Teachers with four or more years of training give the greatest percentage response to adequate emphasis within the old course. Within a future course, an increased percentage of the latter subgroups respond to less emphasis upon traditional content. Thus teachers with three or less years of training appear to be more conservative in their estimate of what may occur to traditional content in a future Chemistry 30 course.

Transitional Content

A difference at the .05 level of significance occurred among

TABLE II

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO YEARS OF TRAINING

Years of training		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
3 or less	N	24	7	11	13	71	3	17	50	15
	%	57.1	16.7	26.2	14.9	81.6	3.5	20.7	61.0	18.3
4	N	117	151	59	71	314	25	112	179	100
	%	35.8	46.2	18.0	17.3	76.6	6.1	28.6	45.8	25.6
5 or more	N	153	152	70	98	289	30	145	169	403
	%	40.8	40.5	19.7	23.5	69.3	7.2	36.0	41.9	22.1
Total	N	294	310	140	182	674	58	274	398	204
	%	39.5	41.7	18.8	19.9	73.7	6.4	31.3	45.4	23.3
TRANSITIONAL CONTENT										
3 or less	N	86	33	0	56	201	3	8	137	93
	%	72.3	27.7	0.0	21.5	77.3	1.2	3.4	57.6	39.0
4	N	600	220	3	243	861	53	46	646	391
	%	72.9	26.7	0.4	21.0	74.4	4.6	4.2	59.2	36.6
5 or more	N	758	304	5	241	906	54	66	651	426
	%	71.5	28.0	0.5	20.1	75.4	4.5	5.8	57.1	37.1
Total	N	1444	557	8	540	1968	110	120	1434	410
	%	71.9	27.7	0.4	20.6	75.2	4.2	4.9	58.2	36.9

TABLE II (continued)

SUPPLEMENTARY CONTENT

3 or less	N	30	1	1	40	21	0	0	18	40
	%	93.8	3.1	3.1	65.6	34.4	0.0	0.0	31.0	69.0
4	N	204	9	1	178	124	7	6	96	182
	%	95.3	4.2	0.5	59.0	38.7	2.3	2.1	33.8	64.1
5 or more	N	253	16	0	189	121	6	21	91	186
	%	94.1	5.9	0.0	59.8	38.3	1.9	7.0	30.6	62.4
Total	N	487	26	2	407	266	13	27	208	408
	%	94.6	5.0	0.4	59.3	38.8	1.9	4.2	32.3	63.5

TABLE III

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

YEARS OF TRAINING

	3 or less N = 24			4 N = 109			5 or more N = 115
	Old	New	Future	Old	New	Future	
Trad.	.01		.05				
Trans.	a	.05					
Supp.	a	a	a				
Trad.	.02		.01				
Trans.	a	.05		a			
Supp.	a	a	a	a	a	a	

a Low expected frequencies required the collapsing of cells and the computation of chi-square from 2X2 tables.

teachers with three or less years of experience and other subgroups according to Table III. The difference was in their perception of emphasis within the new course. No significant differences occurred among subgroups in their perceptions of content within the old or a future course.

A smaller relative percentage of teachers with three or less years of training in comparison to other subgroups responded to too much emphasis within the new course according to Table II. No trends appeared among subgroups in their perceptions of content within the old or a future course. The low level of significant difference and the small number of respondents with three or less years of training prevented an interpretation of years of training as a factor related to differences in teacher perception of transitional content.

Supplementary Content

No significant differences existed among subgroups of teachers in their perception of supplementary content according to Table III.

IV. TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO THE NUMBER OF UNIVERSITY CHEMISTRY COURSES

The response of subgroups in terms of numbers and percentages is shown in Table IV. Significant differences in the perception of adequacy of content according to subgroups is shown in Table V.

The greatest number of significant differences for all categories of content occurred among teachers with two or three and teachers with four or more chemistry courses as shown by Table V. The greatest

number of differences occurred between teachers with two or three and teachers with six or more courses. Teachers with zero or one and four or five courses did not differ significantly. Similarly, teachers with four or more courses did not differ significantly in their perception of adequacy of emphasis placed upon content.

Traditional Content

No significant differences occurred among subgroups with five or fewer university chemistry courses as shown by Table V. Significant differences in perception of the new course occurred between teachers with six or more university chemistry courses and teachers with two or three and four or five courses. Significant differences also occurred between teachers with six or more and three or less courses in their perception of a future course.

In comparison to subgroups with two to five university courses, teachers with six or more courses indicated the new course placed too much emphasis upon content as shown by Table IV. The subgroups with two to five university courses indicated adequate emphasis. Examination of response to a future Chemistry 30 course indicated that as a subgroup's number of university courses increased a corresponding increase occurred in the subgroup's percentage response to less emphasis. The greatest percentage of teachers with six or more courses indicated a decrease in emphasis in the traditional content in comparison to the present course, whereas the greatest percentage of teachers with three or less courses indicated equivalent or more treatment in a future course. A similar pattern existed when teachers with three or less years of training were

TABLE IV

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO NUMBER OF UNIVERSITY CHEMISTRY COURSES

Number of University Chemistry Courses		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
0 - 1	N	58	68	22	44	132	14	42	81	55
	%	39.2	45.9	14.9	23.2	69.5	7.3	23.6	45.5	30.9
2 - 3	N	138	135	60	73	320	19	119	183	87
	%	41.4	40.6	18.0	17.4	77.7	4.6	30.6	47.0	22.4
4 - 5	N	58	51	34	37	143	11	66	77	40
	%	40.6	35.7	23.7	18.4	74.9	5.7	36.1	42.1	21.8
6 or more	N	21	28	11	18	47	11	34	24	14
	%	35.0	46.7	18.3	23.7	61.8	14.5	46.6	32.9	20.5
TRANSITIONAL CONTENT										
0 - 1	N	270	111	0	123	392	26	18	288	209
	%	70.1	29.9	0.0	22.7	72.5	4.8	3.5	55.9	40.6
2 - 3	N	665	258	3	209	888	45	49	767	374
	%	71.8	27.9	0.3	18.3	77.8	3.9	4.1	64.5	31.4
4 - 5	N	298	111	1	129	377	21	26	277	212
	5	72.7	27.1	0.2	24.5	71.5	4.0	5.0	53.8	41.2
6 or more	N	132	38	2	49	156	11	18	113	71
	%	76.7	22.1	1.2	22.7	72.2	5.1	8.9	56.0	35.1

TABLE IV (continued)

SUPPLEMENTARY CONTENT

0 - 1	N	94	2	0	82	46	4	3	37	83
	%	97.9	2.1	0.0	64.1	34.8	1.1	2.4	30.1	67.5
2 - 3	N	226	16	2	174	127	2	5	108	175
	%	92.4	6.7	0.9	57.4	41.9	0.7	1.7	37.5	60.8
4 0 5	N	105	4	0	94	54	2	8	34	96
	%	96.3	3.7	0.0	62.7	36.0	1.3	5.8	24.6	69.6
6 or more	N	45	0	0	40	16	0	6	17	33
	%	100	0.0	0.0	71.4	28.6	0.0	10.7	30.4	58.9

TABLE V

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

NUMBER OF UNIVERSITY CHEMISTRY COURSES

	0 - 1 N = 52			2 - 3 N = 108			4 - 5 N = 53			6 or more N = 20
	Old	New	Future	Old	New	Future	Old	New	Future	
Trans. trad.										
Supp. Trans.	a		.01							
Supp. Trans. Trad.	a	a								
Trans. Trad.										
Supp. Trans.	a			a	.02	.001				
Supp. Trans. Trad.	a	a		a	a	.01				
Supp. Trans. Trad.			.001		.001	.05		.05		
Supp. Trans. Trad.	a		.01	a		.01	a			
Supp. Trans. Trad.	a	a		a	a .05	.001	a	a		

a Low expected frequencies required the collapsing of cells and the computation of chi-square from 2X2 tables.

compared to teachers with four or more years of training.

Transitional Content

No significant differences appeared among subgroups in their perception of the emphasis placed upon transitional content by the old course according to Table V. A difference at the .02 level between teachers with two or three courses and teachers with four or five courses occurred in reference to the new course. Significant differences appeared among subgroups in their perception of content emphasis within a future course.

Examination of percentage responses showed no significant trend which would relate the number of university courses to teacher discernment of adequacy of transitional content.

Supplementary Content

Examination of Table V showed no significant differences among subgroups in their perception of adequacy of emphasis within the old and new courses. Significant differences occurred between teachers with two or three courses and four or more courses in regard to emphasis within a future course.

Examination of Table IV showed that significant differences among subgroups was caused by a number of different emphases. No trend was apparent.

V. TEACHER PERCEPTION RELATIVE TO AREA OF SPECIALIZATION

The response of subgroups in terms of numbers and percentages is

presented in TableVI. Significant differences in the perception of adequacy of content according to subgroups is shown in Table VII.

Teachers with physics-mathematics as their area of specialization appeared to be significantly different from all subgroups with the exception of teachers in the area of chemistry-physics. According to Table VII, the differences occurred generally in perception of transitional and supplementary content.

Traditional Content

No significant differences occurred among subgroups in their response to the adequacy of emphasis within the old or future courses as shown by Table VII. Subgroups in physics-mathematics or chemistry-mathematics and in biological sciences or humanities were significantly different in their perception of adequacy of emphasis within the new course.

A greater relative percentage of teachers in physics-mathematics or chemistry-mathematics indicated that the new course placed too little emphasis upon traditional content according to Table VI, whereas a greater percentage of other subgroups indicated that the new course placed too much emphasis. No differences appeared in teacher discernment of emphasis upon content in a future course. All groups emphasized less or equal emphasis in a future course. Thus factors other than area of specialization appeared to have the greatest effect upon teacher perception of emphasis upon traditional content.

Transitional Content

Teachers in the area of specialization of physics-mathematics were significantly different from teachers in biological sciences and the humanities in their perception of the old course. Differences also occurred between teachers in physics-mathematics and all other groups except the humanities in their perception of content in a future course.

Examination of Table VI showed that a smaller percentage of teachers in the area of physics-mathematics indicated too little emphasis was placed upon transitional content within the old course. A greater percentage of this subgroup indicated too little emphasis within the present course and that more emphasis would occur in a future course. No similar trend was shown by teachers in the humanities.

Supplementary Content

No significant differences appeared among subgroups in their perception of adequacy of supplementary content in the old and new courses according to Table VII. Teachers in the area of physics-mathematics were significantly different from teachers in the areas of biological sciences, chemistry-mathematics and humanities in their perception of a future course.

A greater percentage of teachers in the area of physics-mathematics respond to more emphasis upon supplementary content in a future course. The tendency for this subgroup to be less conservative in their appraisal of emphasis to be placed upon transitional and supplementary content indicates a relationship between teacher perception and this variable.

TABLE VI

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO AREA OF SPECIALIZATION

Area of Specialization		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too Much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
Chem.-Physics	N	43	52	20	31	123	12	54	104	34
	%	37.4	45.2	17.4	18.7	74.1	7.2	28.1	54.2	17.7
Physics-Math.	N	46	52	18	43	108	9	49	67	41
	%	39.7	44.8	15.5	26.9	67.5	5.6	31.2	42.7	26.1
Chem.-Math.	N	91	94	47	60	200	13	83	122	48
	%	39.2	40.5	20.3	22.0	73.3	4.7	32.8	48.2	19.0
Biology-Science	N	34	32	28	16	89	16	42	52	29
	%	36.2	34.0	29.8	13.2	73.6	13.2	34.1	42.3	23.6
Humanities	N	51	44	22	24	109	10	39	59	39
	%	43.6	37.6	18.8	16.8	76.2	7.0	28.5	43.0	28.5
TRANSITIONAL CONTENT										
Chem.-Physics	N	223	85	3	101	371	20	20	256	180
	%	71.7	27.3	1.0	20.5	75.4	4.1	4.4	56.1	39.5
Physics-Math.	N	221	109	1	114	327	11	12	237	193
	%	66.8	32.9	0.3	25.2	72.4	2.4	2.7	53.7	43.6
Chem.-Math.	N	450	182	2	137	583	51	50	440	223
	%	71.0	28.7	0.3	17.8	75.6	6.6	7.0	61.7	31.3
Biology-Science	N	200	69	4	71	248	12	25	191	126
	%	73.3	25.3	1.4	21.5	74.9	3.6	7.3	55.8	36.9
Humanities	N	232	76	0	84	314	14	9	226	143
	%	75.3	24.7	0.0	20.4	76.2	3.4	2.4	59.8	37.8

TABLE VI (continued)

		SUPPLEMENTARY CONTENT								
Chem.-Physics	N	81	2	1	81	45	1	3	36	81
	%	96.4	2.4	1.2	63.8	35.7	0.5	2.5	30.0	67.5
Physics-Math.	N	81	2	0	70	43	0	2	25	84
	%	97.6	2.4	0.0	62.0	38.0	0.0	1.8	22.5	75.7
Chem.-Math.	N	159	11	0	129	73	6	13	64	117
	%	96.4	6.6	0.0	62.0	35.1	2.9	6.7	33.0	60.3
Biology-Science	N	62	4	0	51	34	1	4	33	50
	%	93.9	6.1	0.0	59.3	39.5	1.2	4.6	37.9	57.5
Humanities	N	79	3	0	50	45	3	2	35	58
	%	96.3	3.7	0.0	54.7	42.5	2.8	2.1	36.8	61.1

TABLE VII

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

AREA OF SPECIALIZATION

	Chem.-Physics N = 45			Physics-Mathematics N = 42			Chemistry-Mathematics N = 72			Biological Sciences N = 34			Humanities N = 39
	Old	New	Future	Old	New	Future	Old	New	Future	Old	New	Future	
Supp. Trans.Trad.		.05											
Supp. Trans.Trad.	a												
Supp. Trans.Trad.	a	a	a										
Supp. Trans.Trad.													
Supp. Trans.Trad.	a		.01	a	.01	.001							
Supp. Trans.Trad.	a	a			a	.02							
Supp. Trans.Trad.					.01			.01					
Supp. Trans.Trad.	a			a .05		.01	a						
Supp. Trans.Trad.	a	a	a		a	a .01	a	a					
Supp. Trans.Trad.			.05		.01								
Supp. Trans.Trad.	a			a .02			a		.01	a		.01	
Supp. Trans.Trad.	a	a	a		a	a .05	a	a		a	a	a	

a Low expected frequencies required the collapsing of cells and the computation of chi-square from 2X2 tables.

VI. TEACHER PERCEPTION OF CONTENT RELATIVE TO YEARS OF EXPERIENCE WITH CHEMISTRY 30

For the old course, no response in terms of numbers or percentages for teachers with zero to one year of experience is shown in Table VIII. No comparison between this subgroup and others was made in regard to perception of content in this case. This was caused by low response because of the large number of teachers in the former subgroup who did not have experience with the old course.

From Table IX, it appears that the following subgroups have the greatest differences:

1. Teachers with four or five years of experience and all other subgroups.
2. Teachers with two or three years of experience and teachers with ten or more years of experience.

Traditional Content

Significant differences in perception of the old course existed between teachers with ten or more and teachers with two or three and four or five years of experience according to Table IX. Teachers with two or three and teachers with four or five, or ten or more years of experience were significantly different in their perception of adequacy of emphasis on content in the new course. No differences appeared in teacher cognizance of emphasis in a future course.

Examination of Table VIII shows that teachers with four or less years of experience give a greater percentage response to too little emphasis by the old course than teachers with six or more years of

TABLE VIII

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO YEARS OF TEACHING EXPERIENCE WITH CHEMISTRY 30

Years of Experience		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
0 - 1	N	a	a	a	42	150	12	55	86	57
	%	...	...	...	20.6	73.5	5.9	27.8	43.4	28.8
2 - 3	N	92	74	44	39	167	5	65	101	47
	%	43.8	35.2	21.0	18.5	79.1	2.4	30.5	47.4	22.1
4 - 5	N	67	45	29	24	100	14	36	66	30
	%	47.5	31.9	20.6	17.4	72.5	10.1	27.3	50.0	22.7
6 - 9	N	46	58	21	32	91	6	44	50	21
	%	36.8	46.4	16.8	24.8	70.5	4.7	36.4	46.3	17.3
10 or more	N	80	110	36	44	162	228	73	94	49
	%	35.4	48.7	15.9	19.3	71.1	9.6	33.8	43.5	22.7
TRANSITIONAL CONTENT										
0 - 1	N	a	a	a	158	411	17	46	305	194
	%	...	...	...	27.0	70.1	2.9	8.4	54.1	37.5
2 - 3	N	440	138	3	130	453	20	29	317	248
	%	75.7	23.8	0.5	21.5	75.0	3.5	4.9	53.5	41.6
4 - 5	N	281	103	3	68	310	20	11	231	124
	%	72.6	26.6	0.8	17.1	77.9	5.0	3.0	63.1	33.9
6 - 9	N	222	94	0	63	281	10	12	216	115
	%	70.2	29.8	0.0	17.8	79.1	3.1	3.5	63.0	33.5
10 or more	N	370	197	3	123	490	42	44	369	200
	%	64.9	34.6	0.5	18.8	74.8	6.4	7.2	60.2	32.8

a Of the 57 respondents in the category 0 - 1 years of experience, 51 were non-respondents to the old course because of lack of experience with the content.

TABLE VIII (continued)

		SUPPLEMENTARY CONTENT								
0 - 1	N	a	a	a	101	51	1	3	47	99
	%	...	...	...	66.0	33.3	0.7	2.0	30.2	67.8
2 - 3	N	140	13	0	94	63	3	6	39	112
	%	91.5	8.5	0.0	57.8	41.3	1.9	3.9	21.9	74.2
4 - 5	N	93	6	2	112	59	3	1	46	46
	%	92.1	6.0	1.9	37.4	61.4	1.2	1.1	49.5	49.5
6 - 9	N	84	7	0	54	36	0	6	26	57
	%	92.3	7.7	0.0	60.0	40.0	0.0	6.7	28.1	65.2
10 or more	N	154	6	1	106	59	6	12	56	86
	%	95.1	4.3	0.6	60.0	39.4	0.6	7.8	36.4	55.8

a Of the 57 respondents in the category 0 - 1 years of experience, 51 were non-respondents to the old course because of lack of experience with the content.

TABLE IX

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

YEARS OF EXPERIENCE WITH CHEMISTRY 30

	0 - 1 N = 57			2 - 3 N = 57			4 - 5 N = 38			6 - 9 N = 34			10 or more N=62		
	Old	New	Future	Old	New	Future	Old	New	Future	Old	New	Future			
Supp. Trans.Trad.	b ...														
Supp. Trans.Trad.	b ...		.02												
Supp. Trans.Trad.	b ...	a													
Supp. Trans.Trad.	b ...				.01										
Supp. Trans.Trad.	b ...	.001	.01	a		.01									
Supp. Trans.Trad.	b ...	a .001	.01	a	a .02	.001									
Supp. Trans.Trad.	b ...						.05								
Supp. Trans.Trad.	b ...	.001	.01	a		.05	a	a							
Supp. Trans.Trad.	b ...	a		a	a		a	a .01	.02						
Supp. Trans.Trad.	b ...			.02	.01		.01								
Supp. Trans.Trad.	b ...	.02		a .001	.05	.01	a .05	.05		a	.05				
Supp. Trans.Trad.	b ...	a		a	a	.02	a	a .01	.02	a	a				

a Low expected frequencies required the collapsing of cells and the computation of chi-square from 2X2 tables.

b Of the 57 respondents in the category 0 - 1 year of experience, 51 were non-respondents to the old course because of lack of experience with the content. Therefore, chi-square was not computed.

experience. The subgroup with four or five years of experience provides the greatest percentage response among all subgroups. In regard to the present course, teachers with four or five and ten or more years of experience indicate that too much emphasis is placed upon traditional content in comparison to teachers with two or three years of experience.

Transitional Content

Significant differences in perception of the old course occurred between teachers with ten or more and teachers with two to five years of experience according to Table IX. Significant differences appeared among subgroups with less than one, or ten or more years of experience and other subgroups in their perception of adequacy of content in the present course. Significant differences in perception of emphasis in a future course occurred between teachers with less than four and teachers with more than four years of experience.

Examination of Table VIII shows a decrease in percentage response upon too little emphasis on content in the old course as years of experience increase. In regard to the present course, teachers with more experience give a smaller percentage response to too little emphasis than teachers with more experience. No apparent trend is indicated for teacher perception of a future course.

There is some indication that as years of experience increase, teachers tend to be more conservative in their view of adequacy of content in old and present Chemistry 30 courses. That is, teachers with more experience place greater response upon the adequacy of emphasis on transitional content in the two courses. The lack of a trend in a

future course limits this interpretation to a relationship between experience and the content changes within present or past experiences of the subgroups.

Supplementary Content

No significant differences occurred among subgroups in their cognizance of content in the old course according to Table IX. Teachers with four or five years of experience were different from all other subgroups in their perception of emphasis in both present and future courses.

Examination of Table VIII shows that teachers with four or five years of experience tend to emphasize that present and future courses are adequate in this area whereas a greater percentage of other subgroups indicate too little emphasis in the present and more emphasis in a future course. No apparent reason exists for this difference in perception by the subgroups of teachers.

VII. TEACHER PERCEPTION OF CONTENT RELATIVE TO PHYSICAL SCIENCE CREDITS TAUGHT

The response of subgroups in terms of numbers and percentages is presented in Table X. Significant differences in the perception of adequacy of content according to subgroups is shown in Table XI.

Table XI shows that most differences occur between teachers with less than one-quarter and more than three-quarters of their teaching load in physical sciences. No significant differences occur among subgroups in their perception of supplementary content.

TABLE X

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO RATIO OF PHYSICAL SCIENCE TO TOTAL CREDITS TAUGHT

Ratio of Credits		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
Less than 1/4	N	46	32	9	28	86	4	22	58	36
	%	52.9	36.8	10.3	23.7	72.9	3.4	19.0	50.0	31.0
Between 1/4 & 1/2	N	109	100	43	48	236	22	89	144	73
	%	43.2	39.7	17.1	15.7	77.1	7.2	29.1	47.0	23.9
Between 1/2 & 3/4	N	62	58	35	48	140	17	65	87	46
	%	40.0	37.4	22.6	23.4	68.3	8.3	32.8	44.0	23.2
More than 3/4	N	77	98	52	57	196	16	102	102	47
	%	33.9	43.2	22.9	21.2	72.9	5.9	40.6	40.6	18.1
TRANSITIONAL CONTENT										
Less than 1/4	N	167	77	0	75	264	7	11	203	125
	%	68.4	31.6	0.0	21.7	76.3	2.0	3.2	59.9	36.9
Between 1/4 & 1/2	N	481	212	0	173	659	43	44	461	326
	%	69.4	30.6	0.0	19.8	75.3	4.9	5.3	55.5	39.2
Between 1/2 & 3/4	N	319	101	2	112	452	21	30	350	176
	%	76.0	23.6	0.4	19.1	77.3	3.6	5.4	63.0	31.6
More than 3/4	N	468	141	6	173	559	38	34	398	273
	%	76.1	22.9	1.0	22.5	72.6	4.9	4.8	56.5	38.7

TABLE X (continued)

		SUPPLEMENTARY CONTENT								
Less than 1/4	N	62	2	0	54	34	1	5	27	56
	%	96.9	3.1	0.0	60.7	38.2	1.1	5.7	30.7	63.6
Between 1/4 & 1/2	N	163	16	1	131	90	9	9	72	137
	%	91.1	8.9	0.0	57.0	39.1	3.9	4.1	33.0	62.9
Between 1/2 & 3/4	N	105	5	1	92	56	0	8	54	81
	%	94.6	4.5	0.9	62.2	37.8	0.0	5.6	37.8	56.6
More than 3/4	N	158	7	0	103	87	2	6	62	118
	%	95.8	4.2	0.0	53.7	45.4	1.0	3.2	33.3	63.5

TABLE XI

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

RATIO OF PHYSICAL SCIENCE TO TOTAL CREDITS TAUGHT

	Less than $\frac{1}{4}$ N = 32			Between $\frac{1}{4}$ and $\frac{1}{2}$ N = 82			Between $\frac{1}{2}$ and 3/4 N = 58			More than 3/4 N= 73
	Old	New	Future	Old	New	Future	Old	New	Future	
Supp. Trans.Trad.										
Supp. Trans.Trad.	a									
Supp. Trans.Trad.	a	a								
Supp. Trans.Trad.	.05		.05		.05					
Supp. Trans.Trad.	a			a		.001				
Supp. Trans.Trad.	a	a		a	a					
Supp. Trans.Trad.	.01		.001							
Supp. Trans.Trad.	a .05	.05		a .02			a		.05	
Supp. Trans.Trad.	a	a		a	a		a	a		

a Low expected frequencies require the collapsing of cells and the computation of chi-square from 2X2 tables.

Traditional Content

Significant differences occurred between subgroups with less than one-quarter and more than one-half of their teaching load in physical sciences. The differences were present in their perception of content in the old and future courses as shown by Table XI. No significant differences appeared among subgroups in their discernment of the adequacy of emphasis in the present course.

Teachers with less than one-quarter and teachers with more than one-half of their teaching load in physical sciences appeared to be at opposite extremes in their perception of content in old and future courses. A smaller percentage of the latter subgroups indicated the old course placed too little emphasis upon this content according to Table X. Relative to other subgroups, teachers with less than one-quarter of their teaching load in physical sciences perceived that adequate or more emphasis would be placed upon traditional content in a future course.

Transitional Content

Significant differences appeared between subgroups with less than one-half and more than three-quarters of their teaching load in physical sciences. The differences occurred in their perception of content in the old course. No significant differences were present among subgroups in their view of adequacy of content of the present course. Subgroups with more than one-quarter of their teaching load in physical sciences were significantly different in their perception of content emphasis in a future course.

According to Table X, an increased percentage response to too

little emphasis within the old course appeared to be related to an increase in the ratio of physical science credits taught. However, no trend appeared in teacher response to the present or future course.

Although teacher response to emphasis placed upon content by the old course appeared to be related to the ratio of physical science credits taught by a subgroup, similar patterns did exist for response to the present course. Thus it was difficult to determine whether the ratio of physical sciences was a factor related to the differences. Teachers with less than one-quarter and teachers with more than three-quarters of their teaching load were likely to be located in schools of varying sizes and probably varied in their years of experience. This factor did not appear to be a valid one for stratifying teachers.

VIII. TEACHER PERCEPTION RELATIVE TO ATTENDANCE OR NON-ATTENDANCE AT SEMINARS

The response of subgroups in terms of numbers and percentages is presented in Table XII. Significant differences in the perception of adequacy of content according to subgroups is shown in Table XIII.

According to Table XIII, the greatest number of significant differences existed <u>between</u> the following subgroups of teachers:

1. Teachers who attended C. P. E. T. seminars and other subgroups.
2. Teachers who attended more than one seminar and other subgroups.

Significant differences at the .05 level occurred in two cases <u>among</u> the subgroups of teachers who participated in Chemistry 330, Science Council

TABLE XII

TEACHER PERCEPTION OF CONTENT EMPHASIS RELATIVE TO ATTENDANCE OR NON-ATTENDANCE AT SEMINARS

Non-attendance or kind of seminar		OLD COURSE			NEW COURSE			FUTURE COURSE		
		Too little	Adequate	Too much	Too little	Adequate	Too much	Less	Equal	More
TRADITIONAL CONTENT										
Non-attendance	N	132	106	31	79	338	29	125	194	103
	%	49.1	37.2	13.7	17.7	75.8	6.5	29.6	46.0	24.4
Chem. 330	N	10	16	5	6	22	4	16	14	7
	%	32.3	51.6	16.1	18.7	68.8	12.5	43.2	37.9	18.9
CPET	N	65	67	41	31	139	13	48	87	44
	%	37.5	38.7	23.8	16.9	76.0	7.1	26.8	48.6	24.6
Science Council	N	73	78	36	45	146	15	72	84	37
	%	39.1	41.7	19.2	21.8	70.9	7.3	37.3	43.5	19.2
2 or more	N	14	24	6	20	25	2	13	19	13
	%	31.8	54.5	13.7	42.5	53.2	4.3	28.9	42.2	28.9
TRANSITIONAL CONTENT										
Non-attendance	N	586	219	2	261	976	45	47	678	453
	%	72.6	27.1	0.3	20.4	76.1	3.5	4.0	57.6	38.4
Chem. 330	N	71	23	0	27	67	3	7	56	47
	%	75.5	24.5	0.0	27.9	69.0	3.1	6.4	50.9	42.7
CPET	N	327	143	1	100	395	41	29	310	156
	%	69.4	30.4	0.2	18.7	73.7	7.6	5.9	62.6	31.5
Science Council	N	377	131	4	130	412	27	22	304	214
	%	73.6	25.6	0.8	22.8	72.5	4.7	4.1	56.3	39.6
2 or more	N	83	36	1	22	108	12	15	86	40
	%	69.2	30.0	0.8	15.5	76.0	8.5	10.6	61.0	28.4

TABLE XII (continued)

SUPPLEMENTARY CONTENT

Non-attendance	N	200	13	0	157	180	3	12	125	178
	%	93.9	6.1	0.0	46.2	52.9	0.9	3.8	39.7	56.5
Chem. 330	N	20	3	0	9	17	0	1	11	17
	%	87.0	13.0	0.0	34.6	65.4	0.0	3.5	37.9	58.6
CPET	N	112	9	0	86	44	3	4	40	78
	%	92.6	7.4	0.0	64.7	33.1	2.2	3.3	32.8	63.9
Science Council	N	119	13	1	48	100	1	3	74	64
	%	89.5	9.8	0.7	32.2	67.1	0.7	2.1	52.5	45.4
2 or more	N	31	2	0	19	14	2	4	13	20
	%	93.9	6.1	0.0	54.3	40.0	5.7	10.8	35.1	54.1

TABLE XIII

DIFFERENCES IN PERCEPTION OF TRADITIONAL, TRANSITIONAL, AND SUPPLEMENTARY CONTENT IN OLD, NEW AND FUTURE CHEMISTRY COURSES

ATTENDANCE OR NON-ATTENDANCE AT SEMINARS

	Non-Attendance N = 120			Chemistry 330 N = 10			C. P. E. T. Seminar N = 49			Science Council Seminar N = 56			2 or more N=13
	Old	New	Future	Old	New	Future	Old	New	Future	Old	New	Future	
Trans.Trad.													
Supp. Trans.Trad.	a												
Supp. Trans.	a	a											
Trans.Trad.	.01												
Supp. Trans.	a	.01	.02	a	.05								
Trans.Trad.	a	a .001		a	a .01	a							
Supp. Trans.	.05												
Trans.Trad.	a			a			a	.05	.02				
Supp. Trans.	a	a	.05	a	a	a	a	a .001	a .001				
Trad.		.001			a .05			.001			.02		
Supp. Trans.	a	.01	.001	a	.05		a			a	.05	.02	
Supp.	a	a		a	a	a	a	a	a	a	a .01	a	

a Low expected frequencies required the collapsing of cells and the computation of chi-square from 2X2 tables.

seminars, or did not attend seminars. Compared to the latter subgroups, teachers who participated in Chemistry 330 did not appear to be as significantly different from teachers who participated in C. P. E. T. and two or more seminars.

Traditional Content

Significant differences in perception of the old course existed between teachers who did not attend seminars and teachers who participated in C. P. E. T. or Science Council seminars according to Table XIII. Teachers who participated in two or more seminars were significantly different from other subgroups in their perception of adequacy of emphasis on content in the present course. No significant differences appeared among subgroups in their perception of emphasis in a future course.

Examination of Table XII showed that a greater percentage of teachers who did not attend seminars responded to too little emphasis in the old course. A greater percentage response was given to too little emphasis upon content in the present course by teachers who attended two or more seminars.

Transitional Content

No significant differences existed among subgroups in their perception of the emphasis placed upon transitional content in the old course as shown by Table XIII. Teachers who participated in C. P. E. T. or more than one seminar were significantly different from other subgroups in their perception of content of present and future courses.

Differences occurred because subgroups who participated in

C. P. E. T. or more than one seminar placed a lower percentage response on too little emphasis and a greater percentage response on too much emphasis in the present course, as shown by Table XII. In their perception of a future course, teachers who participated in C. P. E. T. or more than one seminar appeared to be more conservative in their estimate of emphasis to be placed upon newer concepts.

Supplementary Content

No significant differences occurred among subgroups in their perception of supplementary content in the old course according to Table XIII. Teachers who participated in C. P. E. T. or more than one seminar were significantly different from other subgroups in their perception of content in the present course. Significant differences occurred between teachers who particpated in C. P. E. T. and Science Council seminars in their perception of content in a future course.

Differences occurred among teachers who participated in C. P. E. T. or two or more seminars and other teachers because a greater percentage of the latter group responded to adequate emphasis within the present course. All subgroups with the exception of teachers participating in Science Council seminars indicated that a future course would have more content. The latter group tended to be more conservative in their view of the emphasis to be placed upon this content.

IX. SUMMARY

Teacher cognizance of adequacy of emphasis upon traditional, transitional and supplementary content varied according to response to

the old, new and future courses. The response of the total teacher group indicated a decreasing emphasis upon traditional content and an increasing emphasis upon transitional content. Teachers appeared to perceive changes occurring within the area of atomic theory or molecular structure (orbitals). Within the grouping of traditional content, a greater relative percentage of teachers indicated adequate or less emphasis upon atomic structure (Bohr atom) and adequate or more emphasis upon chemical technology in a future course. Similar variations in teacher response to topics in transitional content occurred. This variation in teacher response limited the interpretation which could be made in regard to the broad groups of traditional and transitional content.

Teachers with three or less years of training were significantly different from other teachers in their perception of traditional content in the old and future courses. A tendency was shown within the former subgroup to retain an emphasis upon traditional content. However, the small number of respondents with three or less years of training and the low probability values limited conclusions in regard to years of training for purposes of determining differences in teacher perception.

Teachers with six or more university courses were significantly different from other subgroups in their perception of traditional content. However, the low probability values of chi-square and the small number of respondents with six or more courses limited interpretations in regard to this subgroup. Teachers with two or three courses were significantly different from other subgroups in their perception of

emphasis upon transitional and supplementary content. The former subgroup was more conservative than other subgroups in their view of adequacy of emphasis in present and future courses. Recency and kinds of courses in the background of this subgroup may provide further information in regard to the differences. The lack of a relationship between number of university courses and teacher perception was implied by the data.

Teachers in the area of physics-mathematics tend to be significantly different in their perception of content from all subgroups except teachers in the area of chemistry-physics. Furthermore, a greater percentage of the former group indicate that more emphasis should be placed upon transitional and supplementary content. The presense of only slight differences between teachers in physics-mathematics and humanities or chemistry-physics limited interpretations of data. However, a major topical change in transitional and supplementary content is in atomic theory (orbitals). Thus a possible relationship exists between area of specialization and teacher perception of content change if the change is within the subgroup's area of specialization.

Years of experience as a variable appeared to divide teachers into two major groups:

1. Teachers with four or five years of experience perceived content differently from other subgroups.
2. Teachers with ten or more years of experience were signifi-

cantly different from teachers with two or three and four or five years of experience.

No straight-line tendency relates an increase in experience with Chemistry 30 to perception of the adequacy of the three areas of content studied. That is, an increase in the number of years of experience does not appear to produce a corresponding tendency on the part of teachers to perceive that more traditional content or less transitional-supplementary content should be retained in a Chemistry 30 course. Although no reason is discernible for this type of grouping, this knowledge warrants further investigation of the variable of teacher experience.

Teachers with less than one-quarter and teachers with more than three-quarters of their teaching load in physical sciences were significantly different in their perception of traditional and transitional content. Low probability values of chi-square and lack of consistent trends indicated that this variable was not significant in relating teacher perception to content.

Teachers who participated in C. P. E. T. and two or more seminars were significantly different from other subgroups in their perception of transitional and supplementary content. They were different in the following respects:

1. Their perception of change in transitional content appeared to be <u>more</u> conservative in comparison to other groups. That is, a relatively greater percentage of teachers who participated in C. P. E. T. and two or more seminars indicated too

much emphasis within the present course and equal emphasis in a future course.

2. Their perception of supplementary content in a present course was <u>less</u> conservative than other groups. A greater relative percentage indicated that too little emphasis was placed upon content whereas other groups placed a greater percentage response on adequate emphasis. The two groups were more conservative in their appraisal of supplementary content in a future course.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA PERTAINING TO THE TEXT, LABORATORY AND METHODS OF INSTRUCTION

The data within this chapter is sub-divided into sections in order to examine the information. Tables which indicate perception of items by the total group of teachers are presented. Where significant differences or trends among sub-groups occur, tables are also presented.

I. SELECTED ASPECTS OF THE CHEMISTRY 30 TEXT

This section is used to analyze the following characteristics of the Chemistry 30 text:

1. Textbook definition of terms.
2. Problems provided by the textbook.
3. Density of concepts and reading difficulty.

Each aspect of the textbook is analyzed in terms of the control variables or teacher parameters which include:

1. The number of years of university training.
2. The number of university chemistry courses.
3. The subject area specialization.
4. The number of years of teaching experience in Chemistry 30.
5. The ratio between physical science credits and the total credits taught.
6. Attendance or non-attendance at in-service seminars.

Textbook Definition of Terms

Chemistry 30 teachers perceived the textbook to be adequate in the number of line cuts provided, definition of scientific terms, and in the use of non-scientific vocabulary, as shown in Table XIV.

Significant differences occurred only within the variable of years of training in terms of teacher perception of the difficulty of non-scientific vocabulary. Teachers with four years of training placed greater relative emphasis upon the adequacy of the non-scientific vocabulary according to Table XV. No apparent trend relating years of experience to this item was indicated.

Problems Provided by the Textbook

The greatest percentage of teachers perceived the textbook questions to be thought-provoking but lacking in provision for adequate drill on particular concepts as shown in Table XVI. Teachers also perceived that the textbook did not grade questions explicitly according to the criterion of difficulty.

A large percentage of teachers indicated that the questions were thought-provoking. Thirty-nine or 15.7 per cent of the respondents further qualified this answer by stating that the questions were too difficult for the average student. This was the only statement made in regard to this item.

No significant differences existed among subgroups in their perception of items concerned with the explicit grading of questions or the concept that questions were thought-provoking. Significant differences existed among subgroups within the variables of number of chemistry

TABLE XIV

TEACHER PERCEPTION OF ADEQUACY OF LINE CUTS, DEFINITION OF TERMS, AND NON-SCIENTIFIC VOCABULARY

Item		Excessive	Adequate	Inadequate
Number of line cuts	N	5	179	46
N = 230	%	2.2	77.8	20.0

		Yes	No	Undecided
Scientific terms are adequately defined	N	141	70	21
N = 232	%	60.8	30.2	9.1
Non-scientific vocabulary is too difficult	N	71	126	31
N = 228	%	31.1	55.3	13.6

TABLE XV

TEACHER PERCEPTION OF NON-SCIENTIFIC VOCABULARY
RELATIVE TO YEARS OF TRAINING

Years of training		Too Difficult	Not too Difficult	Undecided
3 or less [a] N = 24	N	8	9	7
	%	33.3	37.5	29.2
4 years [b] N = 107	N	21	70	16
	%	19.6	65.4	15.0
5 or more [c] N = 112	N	48	55	9
	%	42.9	49.2	8.0

[a] chi-square is significant at .05 level for subgroups with 3 or less and 4 years of training.

[b] chi-square is significant at .001 level for subgroups with 4 and 5 or more years of training.

[c] chi-square is significant at .02 level for subgroups with 3 or less and 5 or more years of training.

TABLE XVI

TEACHER PERCEPTION OF ADEQUACY OF QUESTIONS PROVIDED IN TEXTBOOK

Item		Yes	No	Undecided
Questions and/or problems are graded explicitly N = 240	N	92	117	31
	%	38.3	48.8	12.9
Problems are thought-provoking to the average student N = 243	N	187	35	21
	%	77.0	14.4	8.6
Number of problems provided for drill on a concept are adequate N = 245	N	100	135	10
	%	40.8	55.1	4.1

courses and teacher specialization in regard to the adequacy of drill problems. A greater percentage of the subgroups with less than two university chemistry courses or in the areas of physics-mathematics and humanities indicated that the problems were inadequate according to Table XVII.

The lack of a straight-line relationship between number of university chemistry courses and teacher perception of adequacy of drill problems, and the similar perception of apparently unrelated subgroups of physics-mathematics and humanities limited the interpretations which could be made. Because of the lack of significant differences among subgroups in their perception of other items, the control variables used did not appear to be valid in regard to providing differences in teacher perception of the items on problem adequacy.

Density of Concepts and Reading Difficulty

The greatest relative percentage of Chemistry 30 teachers perceived that an adequate number of concepts per section or per chapter was introduced within the text as shown by Table XVIII. Teachers believed that the average student had difficulty in reading the textbook according to Table XIX.

Except for the items which examined the problems provided by the textbook, no other selected items appeared to indicate textbook weaknesses which would produce reading difficulty for the average student. Teachers indicated the following in regard to problems provided by the textbook:

TABLE XVII

TEACHER PERCEPTION OF ADEQUACY OF PROBLEMS FOR DRILL RELATIVE TO NUMBER OF UNIVERSITY CHEMISTRY COURSES AND AREA OF SPECIALIZATION

Number of Chemistry Courses

		Yes	No	Uncertain
0 - 1 [a]	N	12	37	3
N = 52	%	23.1	71.2	5.8
2 - 3	N	52	50	4
N = 106	%	49.1	47.2	3.8
4 - 5 [b]	N	25	27	1
N = 53	%	47.2	50.9	1.9
6 or more	N	6	12	2
N = 20	%	30.0	60.0	10.0
Total Group	N	95	126	10
N = 231	%	41.1	54.5	4.3

TABLE XVII (continued)

Area of Specialization

Chemistry-Physics [c]	N	21	21	2
N = 44	%	47.7	47.7	4.5
Physics-Mathematics [d]	N	8	32	2
N = 42	%	19.0	76.2	4.8
Chemistry-Mathematics [e]	N	31	38	2
N = 71	%	43.7	53.5	2.8
Biological Sciences [f]	N	18	13	2
N = 33	%	54.5	39.4	6.1
Humanities	N	12	26	1
N = 39	%	30.8	56.8	3.9
Total Group	N	90	130	9
N = 229	%	39.3	56.8	3.9

[a] chi-square is significant at .001 level between subgroups with 0 - 1 or 2 - 3 university chemistry courses with a 2X2 table.

[b] chi-square is significant at .02 level between subgroups with 0 - 1 or 4 - 5 university chemistry courses with a 2X2 table.

[c] chi-square is significant at .01 level between subgroups in the area of physics-mathematics and chemistry-physics with a 2X2 table.

[d] chi-square is significant at .001 level between subgroups in the area of physics-mathematics and biological sciences with a 2X2 table.

[e] chi-square is significant at .01 level between subgroups in the area of physics-mathematics and chemistry-mathematics with a 2X2 table.

[f] chi-square is significant at .05 level between subgroups in the area of biological sciences and humanities with a 2X2 table.

TABLE XVIII

TEACHER PERCEPTION OF THE DENSITY OF NEW CONCEPTS INTRODUCED PER CHAPTER AND SECTION

		Excessive	Adequate	Inadequate	Undecided
The number of concepts introduced within the text in each chapter is N = 240	N	75	142	7	16
	%	31.3	59.2	2.9	6.7
The number of concepts introduced within the text in each section is N = 243	N	67	153	8	15
	%	27.6	63.0	3.3	6.2

TABLE XIX

TEACHER PERCEPTION OF READING DIFFICULTY OF THE TEXTBOOK

		Yes	No	Undecided
The average student had little difficulty in reading the text N = 239	N	55	163	21
	%	23.0	68.2	8.8

1. That the number of drill problems were not adequate.
2. That the problems were thought-provoking with indication that problems may have been excessively thought-provoking.
3. That problems were not graded explicitly for difficulty.

Selection of content from parts of chapters, teacher perception of inadequacies in problems, need for teachers to develop articulation among topics, and an apparently inherent reading difficulty within the text according to Jacobson*, may have affected teacher perception of the reading difficulty of the text. If teachers use a newly authorized textbook as an exclusive teaching aid during the initial period of implementation of a new course, an actual reading difficulty occurring within the textbook would limit the use and implementation of the text until teachers adjust to its inadequacies. No significant differences among subgroups occurred within the control variables with the exception of the following:

1. Years of training.
2. Number of university chemistry courses.
3. Years of experience.

Differences among subgroups within the variables of number of university chemistry courses and years of experience occurred at the .05 level. The lack of a trend and the low significant differences did not warrant further consideration of the variables.

---

* Cf. p. 31.

A significant difference between teachers with three or less and ten or more years of experience occurred at the .05 level in regard to their perception of the concept density per section of the text according to Table XX. Similarly, teachers with one or less years of experience were significantly different at the .05 level from teachers with four or five or ten and more years of experience in their perception of concept density per chapter. A higher relative percentage of teachers with the greater experience indicated that the number of concepts per section or chapter was excessive. Although no straight-line relationship existed between years of experience and teacher perception of concept density, further study of differences in teacher perception of this item according to the control variable of experience was indicated.

II. THE LABORATORY AND METHODS OF INSTRUCTION

Teacher perception of time to be devoted to laboratory activities, the purposes of laboratory activities and methods of instruction in Chemistry 30 are examined in the following section.

Teacher Perception of Time for Laboratory Activities

Availability of laboratory facilities was not significantly different from teacher perception of the time which should be spent ideally in laboratory activities in Chemistry 30 in the future but was different from teacher perception of time for laboratory

---

Low response in cells indicating that the percentage of time for laboratory should be above 50 per cent dictated the collapsing of cells in order to compute the chi-square values. This procedure was used to compare the availability of laboratory facilities to the time which should be devoted to laboratory activities.

TABLE XX

TEACHER PERCEPTION OF CONCEPT DENSITY PER SECTION AND PER CHAPTER ACCORDING TO YEARS OF TEACHING EXPERIENCE

Density per Section

Years of Experience		Excessive	Adequate	Inadequate	Undecided
0 - 1	N	14	39	1	2
N = 56	%	25.0	69.6	1.8	3.6
2 - 3	N	12	38	1	5
N = 56	%	21.4	67.9	1.8	8.9
4 - 5	N	10	25	1	2
N = 38	%	26.3	65.8	2.6	5.3
6 - 9	N	7	22	2	2
N = 33	%	21.2	66.7	6.1	6.1
10 or more [a]	N	24	29	3	4
N = 60	%	40.0	48.3	5.0	6.7

Density per Chapter

0 - 1 [b]	N	12	37	2	5
N = 56	%	21.4	66.1	3.6	8.9
2 - 3	N	15	33	0	6
N = 54	%	27.8	61.1	0.0	11.1
4 - 5	N	15	19	1	2
N = 37	%	40.5	51.4	2.7	5.4
6 - 9	N	9	21	1	2
N = 33	%	27.3	63.6	3.0	6.1
10 or more	N	24	32	3	1
N = 60	%	40.0	53.3	5.0	1.7

[a] chi-square is significant at .05 level between subgroups with 0 - 1 or 2 - 3 and 10 or more years of experience with 2X2 tables.

[b] chi-square is significant at .05 level between subgroups with 0 - 1 or 2 - 3 and 10 or more years of experience with 2X2 tables.

activities in 1965-66 at the .05 level of significance as shown by Table XXI. Comparison of laboratory availability to teacher perception of laboratory activities for now and the future indicated significant differences for Science 20.

Further examination of teacher response to laboratory activities in Chemistry 30 and Science 20 is shown in Table XXII on pages 98 - 99. The median indicated by all teachers for availability of the laboratory in Chemistry 30 was 19.8 per cent. The median indicated for laboratory availability in Science 20 was 21.6 per cent.

Teachers with 20 per cent or less laboratory availability tended to be more conservative than other teachers in their perception of time to be spent in both Chemistry 30 and Science 20 now and in the future according to Figure 1 on page 100. All subgroups indicated that time required for laboratory work in Chemistry 30 and Science 20 would increase significantly in the future.

It appeared that availability of laboratory facilities had a slight negative effect upon teacher perception of time to be spent in Chemistry 30 and Science 20. However, knowledge of the emphasis placed upon laboratory experience by the new physical science courses and knowledge of impending change in the Chemistry 30 laboratory may have had compensatory effects upon teacher perception of future time requirements for laboratory activities.

Teacher Perception of the Purposes of Laboratory Work

Ranking of purposes of laboratory work in Chemistry 30 by subgroups of teachers showed no significant differences when tested by

TABLE XXI

CHI-SQUARE TEST TO COMPARE AVAILABILITY OF LABORATORY TO TEACHER PERCEPTION OF TIME IN LABORATORY ACTIVITIES IN 1965 AND 1970

	Laboratory time in 1965-66	Laboratory time in 1970
Availability of laboratory facilities in Chemistry 30	.05	N.S.
Availability of laboratory facilities in Science 20	.001	.02

TABLE XXII

LABORATORY AVAILABILITY IN CHEMISTRY 30 AND SCIENCE 20 COMPARED TO TEACHER PERCEPTION OF TIME IN LABORATORY ACTIVITIES IN 1965-66 AND 1970

Time which should be spent in laboratory in Chemistry 30 in 1965-66

Availability of Laboratory		10%	20%	30%	40%	50%	60% or more
0 - 20%	N	14	49	32	16	8	
N = 119	%	11.8	41.2	26.9	13.4	6.7	
21 - 40%	N	2	12	18	17	7	
N = 56	%	3.6	21.4	32.1	30.4	12.5	
41 - 60 %	N	1	6	5		3	2
N = 17	%	5.9	35.3	29.4		17.6	11.8
61 - 100%	N	4	11	10	4	5	4
N = 38	%	10.5	28.9	26.3	10.5	13.2	10.5
Total Group	N	21	78	65	37	23	6
N = 230	%	9.1	33.9	28.3	16.1	10.0	2.6

Time which should be spent in laboratory in Chemistry 30 in 1970

0 - 20%	N	4	13	25	23	35	11
N = 111	%	3.6	11.7	22.7	20.7	31.5	9.9
21 - 40%	N		3	7	13	20	13
N = 56	%		5.4	12.5	23.2	35.7	23.2
41 - 60%	N	1	3		1	6	6
N = 17	%	5.9	17.6		5.9	35.3	35.3
61 - 100%	N		5	6	6	9	11
N = 37	%		13.5	16.2	16.2	24.3	29.7
Total Group	N	5	24	38	43	70	41
N = 221	%	2.3	10.9	17.2	19.5	31.7	18.4

TABLE XXII (continued)

Time which should be spent in laboratory in Science 20 in 1965-66

0 - 20%	N	11	48	28	15	6	1
N = 109	%	10.1	44.0	25.7	13.8	5.5	0.9
21 - 40%	N	1	12	24	15	7	
N = 59	%	1.7	20.3	40.7	25.4	11.9	
41 - 60%	N	2	3	2	3	11	5
N = 26	%	7.7	11.5	7.7	11.5	42.3	19.2
61 - 100%	N	2	10	7	4	2	7
N = 32	%	6.3	31.3	21.9	12.5	6.3	21.9
Total Group	N	16	73	61	37	26	13
N = 226	%	7.1	32.3	27.0	16.4	11.5	5.8

Time which should be spent in laboratory in Science 20 in 1970

0 - 20%	N	3	17	31	20	26	8
N = 105	%	2.9	16.2	29.5	19.0	24.8	7.7
21 - 40%	N		4	12	19	17	7
N = 59	%		6.8	20.3	32.2	28.8	11.9
41 - 60%	N	1	2		1	10	11
N = 25	%	4.0	8.0		4.0	40.0	44.0
61 - 100%	N	2	3	6	4	5	11
N = 31	%	6.5	9.7	19.4	12.9	16.1	35.4
Total Group	N	6	26	49	44	58	37
N = 220	%	2.7	11.8	22.3	20.0	26.4	16.8

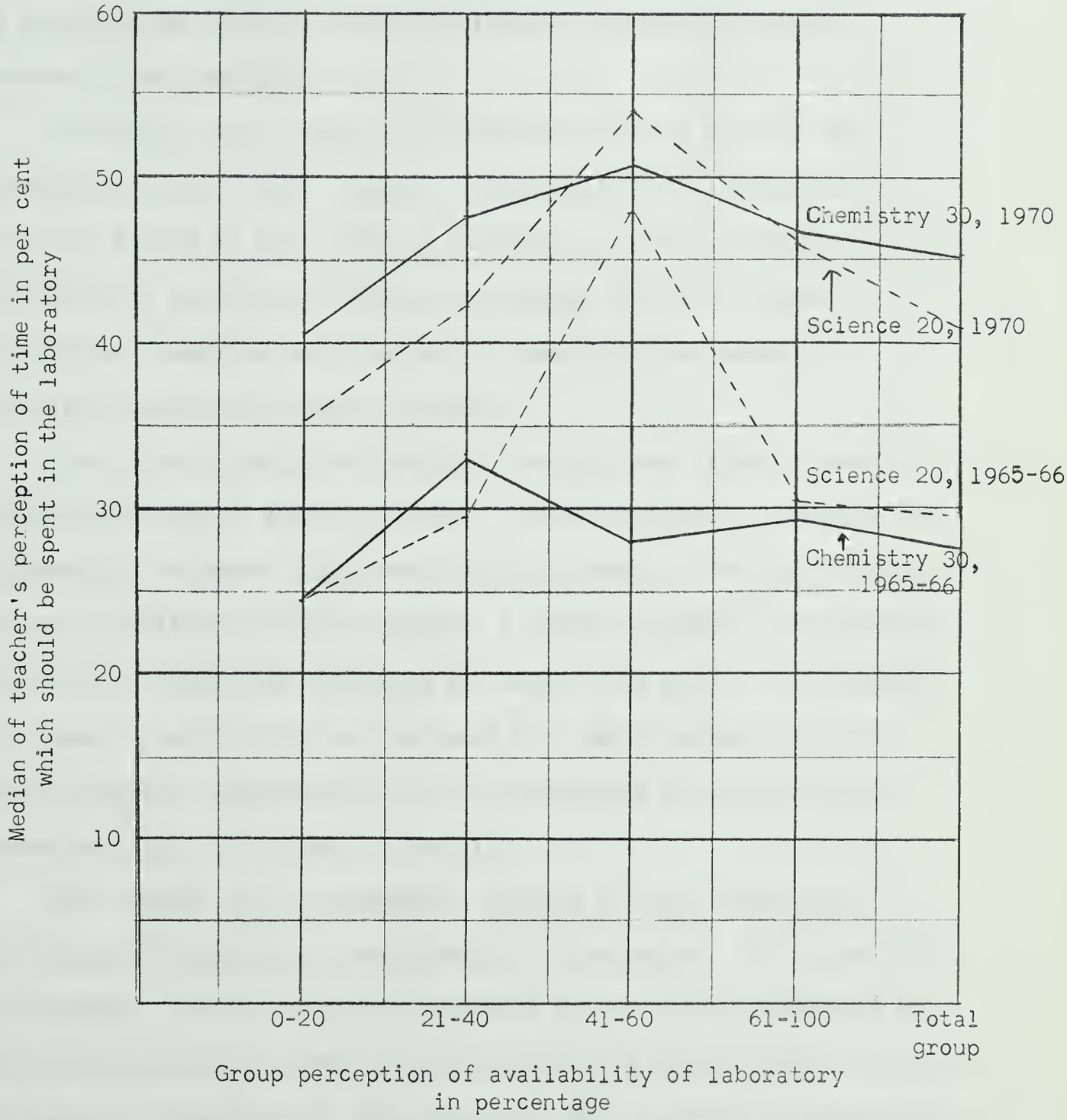

FIGURE 1

THE RELATIONSHIP BETWEEN GROUP PERCEPTION OF LABORATORY AVAILABILITY AND TIME WHICH SHOULD BE SPENT IN THE LABORATORY

means of the Spearman rank correlation. Thus the ranks and medians of purposes of laboratory work for the total group of teachers is shown in Table XXIII. Stratification of teachers by the six variables used did not appear to be valid in order to determine teacher perception of purposes of the laboratory.

Analysis of the ranking of laboratory purposes revealed an apparent conundrum. Class enquiry (investigation of a problem by a class) was ranked as first whereas individual enquiry (investigation by individuals of individual problems) was ranked as last as shown by Table XXIII. Secondly, verification of principles was ranked as vertically equivalent to class enquiry.

Both class enquiry and individual enquiry are oriented toward inductive learning or problem solving. In these kinds of learning, the teachers' and students' roles were likely to change. Teaching by the process of individual enquiry required a greater degree of organization, provision for individual attention and time on the part of the teacher. The teacher's lack of time as indicated by a study conducted by the Alberta Teachers' Association (2) likely precluded this procedure as impractical from the teacher's viewpoint.

The reasons for the equivalent ranking of class enquiry and verification of principles were difficult to determine. The latter kind of laboratory experience tended to provide review and reinforcement of principles previously taught to the student--an opposite kind of learning experience in comparison to class enquiry. That apparently contradictory forces were operative upon teacher perception of the purposes of the

TABLE XXIII

TEACHER PERCEPTION OF PURPOSES OF LABORATORY WORK IN CHEMISTRY 30

Purpose of Laboratory	Rank	Median
Class enquiry	1	2.08
Verification of principles	2	2.14
Laboratory techniques	3	2.76
Qualitative and quantitative analysis	4	3.32
Individual enquiry	5	3.85

laboratory may be postulated. Teacher experience with a verification-type of manual and laboratory in high schools may have led to the high ranking of the verification laboratory. Knowledge of the kinds of laboratory experiences emphasized by new physical science courses may have led to the high ranking by teachers of the purpose of class enquiry. The problem posed by this ranking of laboratory purposes warranted further investigation of variables which may indicate differences among subgroups.

Teacher Perception of Teaching Methods

Ranking of the most effective teaching methods in Chemistry 30 by subgroups of teachers indicated no significant differences when tested by means of the Spearman rank correlation. Thus the six control variables used did not appear valid for stratification of teachers in order to determine teacher perception of teaching methods.

The lecture-demonstration-laboratory method which represented a traditional method was ranked as most effective by teachers of Chemistry 30 according to Table XXIV. Teachers also appeared to perceive methods which involved demonstration as more effective than methods which involved the use of laboratory.

All methods which are ranked by teachers may be fruitfully used to teach chemistry, but the discussion-laboratory may be the most effective for teaching class enquiry. The ranking of discussion-laboratory as the fifth most effective method and apparent teacher preference for more traditional modes of teaching may be a reflection of the objectives served by the teaching of science in Alberta and of

TABLE XXIV

TEACHER PERCEPTION OF EFFECTIVE TEACHING METHODS IN CHEMISTRY 30

Teaching Methods	Rank	Median
Lecture-demonstration-laboratory N = 214	1	1.32
Lecture-demonstration N = 195	2	2.32
Discussion-demonstration N = 199	3	3.03
Demonstration-laboratory N = 155	4	3.73
Discussion-laboratory N = 160	5	4.00
Lecture N = 179	6	5.23
Discussion N = 141	7	5.80

teacher familiarity with the first-ranked method.

Summary

Among the selected characteristics of the textbook, teacher response indicated a reading difficulty for the average student and inadequacy in terms of problems provided for drill on a concept. Response by teachers to items on concept density and difficulty of vocabulary implied that these characteristics were not factors which were perceived as related to the reading difficulty. Insufficient items were selected to determine the reasons for teacher response to reading difficulty and inadequacy of drill problems. Teacher perception of reading difficulty within the text may have been affected by the need for teacher familiarization with the new concepts, the development of articulation among the topics and an apparently inherent reading difficulty within the text. If a textbook was considered an important teaching aid during the initial period of implementation of a new course, the occurrence of an actual reading difficulty within the text would limit its use and implementation until adjustment to the text's inadequacies occurred among the teachers.

Stratification of teachers according to the control variables did not appear to affect teacher perception of the items. One exception occurred in teacher perception of concept density. A greater relative percentage of teachers with ten or more years of experience replied that the concept density was too great. Teachers with one or less years of experience placed greater emphasis upon the adequacy of concept density. Although no direct relationship existed between teacher response and the number of years of experience, further study of

the control variable in regard to this item was believed to be warranted.

Availability of laboratory facilities appeared to be a factor affecting teacher perception of time to be spent in laboratory activities during the present year but did not appear to affect teacher perception of the future. Teachers who stated that their laboratory facilities were available for less than 21 per cent of the time tended to be more conservative in their estimate of the percentage of time which should be spent in the laboratory in the future. This pattern was indicated in their perception of laboratory time both now and in the future for Science 20 and Chemistry 30.

Among the purposes of the laboratory as perceived by teachers, class enquiry was ranked as first and individual enquiry as last. Both functions of the laboratory are oriented towards an inductive learning process. Thus the ranking presented an apparent contradiction. A number of factors which may have provided a basis for this variation in ranking were:

1. Belief by teachers that both processes attained similar objectives.
2. The necessity for more individual attention within the process of individual enquiry.
3. Lack of present laboratory facilities in some cases.
4. Lack of preparation time for the teacher.

A second contradiction appeared because of the virtually equivalent ranking of class enquiry and verification of principles. The two

processes attempt to achieve different objectives: normally student observation and synthesis of observations by the method of class enquiry, and student review of previously learned principles by the method of verification of principles. The former kind of laboratory experiences have appeared in the new courses developed by the CHEM Study and the Chemical Bond Approach groups. The latter kind of laboratory experiences have been implicit within previous laboratory manuals used in Chemistry 30. Further investigation of this item and variables which may indicate differences among subgroups was warranted.

The lecture- demonstration-laboratory method was ranked as the most effective method of teaching. Teachers also appeared to perceive the demonstration as an important part of science teaching methods. Discussion and discussion-laboratory methods were ranked as fifth and seventh among the seven items. These items may be used effectively in the promotion of enquiry on the part of the student.

Teacher preference for more traditional modes of teaching may have indicated the limited objectives served by the teaching of Chemistry 30 in Alberta and the familiarity of teachers with the effectiveness of the first-ranked method. Lack of significant differences among subgroups in their ranking of the most effective teaching methods rejected these variables for the purpose of teacher stratification.

CHAPTER VI

ANALYSIS AND INTERPRETATION OF DATA RELATIVE TO METHODS OF CURRICULUM CHANGE

The data within this chapter is concerned with selected aspects of curriculum change. The items analyzed are grouped according to perception of teacher participation in curriculum change and teacher perception of aids which may be provided in curriculum change.

I. TEACHER PARTICIPATION IN CURRICULUM CHANGE

Teacher Experimentation with Courses or Multiple Texts in Chemistry 30 and Science 20

A higher percentage of teachers preferred that teachers be allowed to develop courses rather than to experiment with multiple texts in Chemistry 30, as found in Table XXV. Teacher response to experimentation with courses or multiple texts in Science 20 indicated a similar trend. A chi-square test applied to teacher response to the questions of experimentation with courses or multiple texts showed significant differences at the .001 level.

The chi-square test applied to teacher response to the question on experimentation with courses in Chemistry 30 and Science 20 was significantly different at the .001 level. The same level of significant differences was obtained when teacher response to multiple texts in Science 20 was compared to response to multiple texts in Chemistry 30. A greater percentage of teachers preferred experimentation with courses

TABLE XXV

TEACHER PERCEPTION OF EXPERIMENTATION WITH NEW SCIENCE COURSES OR MULTIPLE TEXTS

		Yes	No	Undecided
In Chemistry 30 a teacher should be allowed to choose among authorized texts rather than a prescribed text [a]	N %	98 39.8	116 47.2	32 13.0
In Science 20 a teacher should be allowed to choose among authorized texts rather than a prescribed text [b]	N %	141 58.0	81 33.3	21 8.6
Teachers should be allowed to experiment with or develop courses in Chemistry 30 [c]	N %	125 51.9	64 26.6	52 21.6
Teachers should be allowed to experiment with or develop courses in Science 20	N %	180 74.1	32 13.2	31 12.8

[a] chi-square test is significant at .001 level between population response to choice among texts for Chemistry 30 and choice among texts for Science 20 or experimentation with courses in Chemistry 30.

[b] chi-square test is significant at .01 level between population response to choice among texts for Science 20 and experimentation with courses in Science 20.

[c] chi-square test is significant at .001 level between population response to experimentation with courses in Chemistry 30 and experimentation with courses in Science 20.

or the use of multiple texts in Science 20 rather than in Chemistry 30, according to Table XXV. This definite trend in teacher response indicated that a year other than a final year of high school would be preferable for experimentation from the viewpoint of the teacher. Similarly, the use of multiple texts did not appear to be held in as much favor as the use of a single text in Chemistry 30. Greater acceptance of the use of multiple texts occurred in teacher perception of Science 20. Thus, it appeared that a major operative factor was Chemistry 30 as a final high school chemistry course. Contributing factors may have been the use of a standardized final examination essentially based upon a program of studies and a single text, as well as difficulties inherent in the use of many texts for the development of a course. In addition, the comments of forty teachers showed concern with the problem of articulation between Science 20 or other junior sciences and Chemistry 30.

Teachers in the physics-mathematics area of specialization were significantly different from teachers in chemistry-mathematics and the biological sciences in their perception of experimentation with courses in Chemistry 30, as shown in Table XXVI. Teachers in the physics-mathematics area of specialization were both more undecided and placed less emphasis upon the allowance for experimentation with Chemistry 30. No apparent reason related this response to the variable.

The number of university chemistry courses appeared to be a factor affecting teacher response to the four items related to use of multiple texts and experimentation with courses. Significant differences

TABLE XXVI

TEACHER PERCEPTION OF EXPERIMENTATION WITH CHEMISTRY 30 ACCORDING TO AREA OF SPECIALIZATION

Area of Specialization		Yes	No	Undecided
Chemistry-Physics	N	23	9	12
N = 44	%	52.3	20.5	27.3
Physics-Mathematics [a]	N	15	11	15
N = 41	%	36.6	26.8	36.6
Chemistry-Mathematics	N	40	21	10
N = 71	%	56.3	29.6	14.1
Biological Sciences [b]	N	22	8	4
N = 34	%	64.7	23.5	11.8
Humanities	N	21	9	6
N = 36	%	58.3	25.0	16.7

[a] chi-square test is significant at .02 level between subgroups in the area of physics-mathematics and chemistry-mathematics.

[b] chi-square test is significant at .05 level between subgroups in the area of physics-mathematics and biological sciences.

occurred among teachers with four or more chemistry courses and less than four chemistry courses in their perception of the use of multiple texts in Science 20, as found in Table XXVII. No significant differences existed among the subgroups in their response to other items. However, with an increase in number of university chemistry courses, a corresponding increase occurred in the percentage of teachers who specified that experimentation should be allowed in the development of new courses and the use of multiple texts in Science 20 and Chemistry 30. Sufficient evidence was indicated for further consideration of this variable for purposes of stratification of teachers.

No significant differences existed among subgroups within the variable of years of experience in their perception of the items related to Chemistry 30. For Science 20, no trend among subgroups with the exception of teachers with ten or more years of experience was shown by Table XXVIII on page 114. Insufficient evidence existed for further consideration of this variable in regard to the items.

The chi-square test applied to the control variables of years of training, ratio of physical science credits taught, and attendance at seminars indicated no significant differences among subgroups. Thus, with the exception of the control variable of the number of university chemistry courses, insufficient evidence was found to warrant further consideration of the variables in regard to the items.

Revision of a Course by Use of Supplements and Inhibitory Effect of Teachers' Guides

A greater percentage of teachers favored the use of supplements

TABLE XXVII

TEACHER PERCEPTION OF EXPERIMENTATION WITH SCIENCE COURSES OR MULTIPLE TEXTS ACCORDING TO THE NUMBER OF UNIVERSITY CHEMISTRY COURSES

Item		Number of Chemistry Courses			
		0 - 1 N=52	2 - 3 N=108	4 - 5 N=52	6 or more N=19
		Percentage of Subgroup			
In Chemistry 30, teacher should be allowed to choose among authorized texts rather than a prescribed text	Yes	30.8	33.3	51.9	57.9
	No	55.8	51.9	38.5	26.3
	Undecided	13.5	14.8	9.6	15.8
In Science 20, a teacher should be allowed to choose among authorized texts rather than a prescribed text	Yes	49.0	51.9	69.2[b]	89.5[a]
	No	41.2	37.7	23.1	10.5
	Undecided	9.8	10.4	10.5	0.0
Teachers should be allowed to experiment with or develop courses in Chemistry 30	Yes	42.9	49.5	64.7	63.2
	No	28.6	28.0	19.6	15.8
	Undecided	28.6	22.4	15.7	21.1
Teachers should be allowed to experiment with or develop courses in Science 20	Yes	62.7	74.5	83.0	83.3
	No	17.6	12.3	7.5	11.1
	Undecided	19.6	13.2	9.4	5.6

[a] Chi-square test is significant at .01 level for subgroups with six or more and less than four university chemistry courses. 2X2 tables were used in the comparison.

[b] Chi-square test is significant at .05 level for subgroups with four or five and less than four university chemistry courses. 2X2 tables were used in the comparison.

TABLE XXVIII

PERCENTAGE RESPONSE TO ITEMS RELATED TO SCIENCE 20 ACCORDING TO YEARS OF EXPERIENCE

Item		Years of Experience				
		0 - 1 N=57	2 - 3 N=56	4 - 5 N=38	6 - 9 N=33	10 or more N=59
In Science 20, a teacher should be allowed to choose among authorized texts rather than a prescribed text	Yes	64.9	64.3[b]	57.9	69.7[c]	39.0[a]
	No	26.3	25.0	31.6	27.3	52.5
	Undecided	8.8	10.7	10.5	3.0	8.5
Teachers should be allowed to experiment with or develop courses in Science 20	Yes	78.2	82.1	78.4	73.5	60.7[d]
	No	7.3	8.9	10.8	14.7	23.0
	Undecided	14.5	8.9	10.8	11.8	16.4

[a] chi-square is significant at .02 level between subgroups with 10 or more and 0 - 1 years of experience.

[b] chi-square is singificant at .05 level between subgroups with 10 or more and 2 - 3 years of experience.

[c] chi-square is significant at .05 level between subgroups with 10 or more and 6 - 9 years of experience.

[d] chi-square is significant at .05 level between subgroups with 10 or more and 2 - 3 years of experience.

for annual revision of the Chemistry 30 course. The percentage difference did not indicate a major tendency to favor this kind of revision. A high percentage of teachers did not accept an inhibitory effect on the part of a teachers' guide in its first year of use, as shown by Table XXIX. An increased percentage of teachers believed that extended use of a teachers' guide may inhibit the presentation of a new course.

Teacher response to the use of supplements showed no significant differences among subgroups within the control variables. Teacher perception of the use of a teachers' guide in the first year showed no significant differences among subgroups except between teachers in physics-chemistry and other subgroups in the area of teacher specialization. However, no reason was apparent for the stratification of teachers on this basis. Response to the item on the inhibitory effect of continued use of the teachers' guide showed significant differences among subgroups within the variable of attendance at seminars. Inspection of Table XXX on page 117 indicated that teachers who attended seminars favored the continued use of the guide in comparison to teachers who did not attend seminars. Major differences occurred with teachers who attended Chemistry 330 and two or more seminars. However, this may have been the result of the small samples represented in the groups.

There is some evidence that teachers who attend seminars are more conservative than teachers who do not attend seminars in their perception of change within this item. Further knowledge of the characteristics of teachers who attend seminars is necessary in order to

TABLE XXIX

TEACHER PERCEPTION OF THE USE OF SUPPLEMENTS AND TEACHERS' GUIDES

		Yes	No	Undecided
The Chemistry 30 course should be revised annually by means of use of supplements.	N	114	94	35
	%	46.9	38.7	14.4
A detailed Teachers' Guide may inhibit the presentation of a new course in the first year.	N	32	178	33
	%	13.2	73.3	13.6
A detailed Teachers' Guide may inhibit the presentation of a new course in later years.	N	91	112	38
	%	37.8	46.5	15.8

TABLE XXX

TEACHER PERCEPTION OF CONTINUED USE OF THE TEACHERS' GUIDE ACCORDING TO ATTENDANCE OR NON-ATTENDANCE AT SEMINARS

		Yes	No	Undecided
Non-attendance at seminars [a]	N	51	42	24
N = 117	%	43.6	35.9	20.5
Chemistry 330	N	2	7	1
N = 10	%	20.0	70.0	10.0
C. P. E. T. [b]	N	17	28	4
N = 49	%	34.7	57.1	8.2
Science Council seminar	N	19	26	8
N - 53	%	35.8	49.1	15.1
Two or more seminars	N	2	9	1
N = 12	%	16.7	75.0	8.3
Attendance at seminars	N	40	70	14
N = 124	%	32.3	56.5	11.3

[a] chi-square is significant at the .01 level between teachers who did not attend seminars and teachers who attended seminars.

[b] chi-square is significant at the .05 level between teachers who did not attend seminars and teachers who attended C. P. E. T. seminars.

determine the reason for this kind of response.

Teacher Perception of the Final Mark in Chemistry 30

Whereas a greater relative percentage of teachers replied that the confidential mark should be a portion of the final mark in Chemistry 30, a greater percentage of teachers indicated that the total mark should not be determined by the teacher. The reversal of the relative percentages of teachers in their perception of the two items was indicated by the response in Table XXXI. The problem of variation in standards was indicated as a factor which prevented teachers from stating that the final mark should be determined by the teacher. Conversely, the evaluation of the year's study by a student on a single examination and a lack of satisfactory evaluative techniques for other than factual knowledge may have been factors which led teachers to indicate that a portion of the final mark should be obtained from a teacher's evaluation.

Examination of response by subgroups within the control variables indicated that the variables were not factors related to teacher cognizance of the items. However, apparent teacher perception of a preference for change in the emphasis allotted to a final examination in Chemistry 30 signified a need for further investigation.

Teacher Perception of the Purposes of Chemistry Refresher Courses

The total population of teachers was very definite in their response to the need for a refresher program previous to the introduction of a new course. The need for this form of introduction was indicated by 92.2 per cent of the teachers, whereas less than one per cent stated that this procedure was unnecessary. The relatively high

TABLE XXXI

TEACHER PERCEPTION OF ITEMS RELATED TO THE TEACHER'S CONFIDENTIAL MARKS AND THE STUDENT'S FINAL MARK

		Yes	No	Undecided
Teacher's confidential mark as a portion of student's final mark	N	154	76	16
	%	62.6	30.9	6.5
Teacher's mark as final mark	N	37	161	43
	%	15.4	66.8	17.8

importance placed by teachers upon the presentation of new concepts in the refresher program was illustrated by Table XXXII. The median difference between the first ranked purpose of presentation of concepts and the second ranked purpose of acquaintance with laboratory work of the new course was 1.41. The median difference between the second and fourth ranked purpose was 0.37. Subgroups of teachers always ranked the purpose of acquainting the teacher with the concepts of the new course as most important. Both the high ranking of acquaintance with concepts and similarity among teacher rankings of the other purposes appeared to be significant. Past curriculum changes in Alberta were textbook-oriented and relatively minor in nature (27). The curriculum change occurred in a final high school year and affected the kinds of concepts presented. These factors may have been a basis for the high ranking of concept presentation in a refresher course. The generally less pragmatic nature of philosophy and teaching methods may have been additional factors and therefore a basis for their low positions in the rankings of teachers. Comparison of the responses of subgroups to purposes of a refresher program showed significant differences. The differences indicated no pattern within the variable considered. Thus the control variables used did not appear to be valid for purposes of stratifying teachers in regard to teacher perception of purposes of refresher courses.

The ratings of purposes had important implications for the successful functioning of refresher programs and the implementation of CHEM Study or C. B. A. chemistry into Alberta high schools. The high

TABLE XXXII

TEACHER PERCEPTION OF THE PURPOSES OF CHEMISTRY REFRESHER COURSES

Concepts of new course N = 237		Laboratory work N = 222		Philosophy of new course N = 215		Teaching Methodology N = 225	
Rank	Median	Rank	Median	Rank	Median	Rank	Median
1	1.17	2	2.58	3	2.85	4	2.95

priority placed upon introduction of new concepts as a purpose of a refresher program may have been a reflection of teacher perception of curriculum change as a content change. This kind of response may have been affected by the kind of change which occurred in Chemistry 30.

A basis for rapid acceptance on the part of teachers of a curriculum change in content may be served by early provision of knowledge of new concepts. However, many of the new science courses have attempted to initiate changes both in content and teaching methods. Teacher ratings of purposes other than the introduction of new concepts indicate a difficulty which may occur if a refresher program concerned with methods and philosophy of a new course is provided. Dissatisfaction on the part of participating teachers may possibly occur because of differences between teacher perceptions and objectives of the program. Teacher perceptions also indicate the difficulty of successfully implementing a curriculum change which attempts to affect teaching methods or the philosophy of a science program.

Teacher Perception of Methods of Introduction of a New Course

Of the total teacher population, 60.0 per cent stated that a new course should be introduced into schools on a compulsory basis. Significant differences existed among subgroups within the variable of teacher specialization. No significant trend was indicated. A limited number of teachers who stated that the course should be introduced on a compulsory basis replied to the question on time limits, with the result that the question received only 44.5 per cent of the total possible replies. Secondly, confusion appeared to be present in the interpretation of two

parts of the item concerned with who should decide upon optionality. The data for these questions were reported in Appendix C.

Summary

The response of teachers appeared to indicate that teacher experimentation with chemistry courses should occur in a year other than the final year of a chemistry course. A similar pattern also existed within the response of teachers to the question of teacher choice of authorized texts rather than a prescribed text. The problems of articulation between Science 20 and Chemistry 30, a standardized test based upon a single text, and the difficulties inherent in the use of multiple texts may have been factors affecting teacher response. A consistent pattern of response implied that the teacher with more background in chemistry preferred to experiment with new courses in science. No significant trends were shown by subgroups within other variables.

The use of supplements in revison was favored by a slightly larger percentage of the total teacher population. Teachers did not appear to perceive teachers' guides as inhibiting to the presentation of a new course in the first year of use. Continued use of guides appeared to be perceived as inhibitory by a greater percentage of teachers. No significant trends were indicated by differences among subgroups within the variables.

Teachers appeared to favor the inclusion of the confidential mark within a student's final mark, but did not favor the use of a confidential mark only as a basis for a final mark. Concern for variation of standards,

evaluation of a year's work on a single examination, and the kinds of evaluation which may be accomplished by a written examination may have been factors affecting this position. Further investigation of the items was warranted by teacher response to the items. No differences in teacher perception occurred among the subgroups within the control variables.

Teacher response was overwhelmingly in favor of provision of refresher programs before the introduction of a new course. Teacher perception of the purposes of a refresher course showed that major emphasis should be placed upon acquainting the teacher with the concepts in the new course. Other purposes were perceived as approximately equivalent in terms of importance. The occurrence of change in a year involving Departmental examinations, the type of final evaluation, and the short period of time between the change and this study may have been some factors causing a concept-orientation towards refresher courses. No pattern was illustrated by the differences among subgroups of teachers. The limited perceptions by teachers of the purposes of refresher courses appeared to place a temporary restriction upon the effectiveness of refresher programs and curriculum changes which attempted to develop other than content change. Further investigation of the purposes of a refresher course is warranted after a curriculum change which attempts to affect the teaching procedure.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The order of the summary and conclusions is the same as that of the hypotheses stated in Chapter I. The conclusions are divided into two broad classes, those related directly to the hypotheses and general conclusions. Summaries and conclusions related to a hypothesis are given according to the trends as shown by the response of the total group of respondents and by the subgroups of teachers within the control variables.

I. CONCLUSIONS RELATED TO TEACHER PERCEPTION OF CONTENT IN THE PAST, PRESENT, AND FUTURE CHEMISTRY 30 COURSES

A slight tendency existed among teachers to perceive a decreasing emphasis upon traditional content. Teachers also perceived an increasing emphasis upon transitional and supplementary content. Within the category of transitional content, teachers appeared to perceive content changes which would place greater emphasis upon topics such as atomic structure (orbitals), molecular structure, and organic chemistry.

A conclusion in regard to the categories of traditional and transitional content must be limited because of variations in percentage responses to topics within a category. This was illustrated by teacher response to the traditional content of chemical technology and atomic structure (Bohr atom). A greater relative percentage of teachers perceived a decrease in the use of the concept of the Bohr atom as compared to the topic of chemical technology, whereas a greater relative

percentage of teachers perceived a greater emphasis upon chemical technology.

Hypothesis 1: There are significantly different perceptions of the adequacy of traditional, transitional, and supplementary content in the chemistry program for 1963-64, for 1964-65, and of future emphasis to be placed upon this content among categories of teachers according to the control variables.

Years of Training

Teachers with three or less years of training were significantly different from other subgroups of teachers in their perception of traditional content in the old and future courses. Similarly, significant differences at the .05 level occurred between teachers with three or less years of training and other subgroups in their perception of transitional content. The small number of respondents with three or less years of training and the occurrence of low probability values indicated that the use of the variable of years of training for purposes of determining differences in perception among teachers was not valid.

Number of University Chemistry Courses

Teachers with six or more courses were significantly different from other subgroups in their perception of traditional content. However, the low probability values of chi-square and the small number of respondents with six or more courses led to the conclusion that the differences were likely due to chance.

Teachers with two or three courses were significantly different from subgroups with more courses in their perception of transitional and supplementary content. No apparent trend related the number of university chemistry courses to teacher perception of the degree of emphasis to be

placed upon the content. Therefore, the variable did not appear to be valid for purposes of stratification of teachers.

Area of Teacher Specialization

Teachers in the area of physics-mathematics tended to be significantly different in their perception of content from all subgroups except teachers in the area of chemistry-physics. Furthermore, a greater percentage of the former subgroup indicated that more emphasis should be placed upon transitional and supplementary content. Thus teachers in the area of physics-mathematics tended to be less conservative in their appraisal of the emphasis to be placed upon content within these categories. This may possibly be explained by the presence within the categories of concepts related to the quantum theory, originally developed in the field of physics. The evidence indicated a possible relationship between area of specialization and teacher perception of content change, if the change is within the teacher's area of specialization. Further investigation of this variable on a topical basis is warranted.

Years of Experience with Chemistry 30

The variable of years of experience appeared to divide teachers into two major groups:

1. Teachers with four or five years of experience perceived content differently from other subgroups.
2. Teachers with ten or more years of experience were significantly different from teachers with two to three, or four to five years of experience.

There was some evidence that as years of experience increased, teachers indicated that transitional content was adequately emphasized in the old and new Chemistry 30 courses. No straight-line tendency related an increase in experience in Chemistry 30 to perception of the other areas studied. The lack of a trend within the area of traditional content prevented acceptance of this variable for the purpose of determining teacher perception of content change. However, the presence of two subgroups which were consistently significantly different from most subgroups and of a trend within transitional content indicated the need for further investigation of this variable.

Ratio of Physical Science Credits Taught

Statistically significant differences occurred between teachers with less than one-quarter and teachers with more than one-quarter of their teaching load in physical sciences in their perception of traditional and transitional content. The lack of trends within their response and the presence of one-half of the differences at the 5 per cent level of significance indicated that the variable was not significant in relating teacher perception to adequacy of content change.

Attendance or Non-attendance at Seminars

Teachers who participated in two or more seminars were significantly different from other groups in their perception of transitional content with the new course. Because of the small number of respondents and the lack of a pattern within the former group's responses, the investigator considered the variable invalid for purposes of stratification of teachers in regard to perception of traditional content.

Teachers who particpated in C. P. E. T. and two or more seminars were significantly different from other subgroups in their perception of transitional and supplementary content. They were significantly different in the following respects:

1. Their perception of change in transitional content appeared to be more conservative in comparison to other groups. That is, a relatively greater percentage of teachers who participated in C. P. E. T. or two or more seminars indicated too much emphasis within the present course and equal emphasis in a future course.
2. Their perception of supplementary content in a present course was less conservative than other subgroups.
3. The C. P. E. T. subgroup was slightly less conservative in their appraisal of supplementary content in a future course.

Because eleven out of thirteen teachers with two or more seminars had experience with C. P. E. T. and both subgroups indicated similar trends, the two subgroups should have been examined as one subgroup. The hypothesis of differences in perception was tentatively accepted on the basis of the statistical evidence and the presence of trends within the response of subgroups. However, the following reservations in regard to acceptance of the hypothesis were made:

1. Investigation of the subgroups' perceptions of topics within the categories of transitional and supplementary content may have revealed significantly different trends. Thus the categorization of topics may have produced the statistical

effects shown.

2. The lack of an apparent reason for the negative relationship between the subgroup's perception of emphasis on transitional content and a positive relationship in perception of supplementary content indicated a need for further investigation.
3. Further investigation of the characteristics of teachers who participated in C. P. E. T. seminars was warranted.

II. CONCLUSIONS RELATED TO TEACHER PERCEPTION OF THE TEXTBOOK AND SELECTED TEACHING METHODS

Adequacy of the number of line-cuts, definitions, number of concepts per section or chapter, kinds and gradation of problems, and reading difficulty were examined in relation to the textbook.

Hypothesis 2: There are significantly different perceptions of selected aspects of the text Chemistry by Sienko and Plane and about the effectiveness of selected teaching methods, among categories of teachers according to the control variables.

Adequacy of Line-cuts and Definition of Terms

Teachers in all subgroups perceived the number of line-cuts and the quality of definitions as adequately presented in the textbook. A lack of sufficient evidence prevented acceptance of the hypothesis that subgroups based upon the control variables had significantly different perceptions of the items.

Adequacy of Problems

Teacher response indicated a tendency to perceive as inadequate the kinds and gradation of problems within the text. Teachers in the area of physics-mathematics and with less than two university chemistry

courses were significantly different from other subgroups in their perception of the adequacy of drill problems. No significant reason for differences was apparent to the investigator. No significant differences occurred among subgroups in their perception of other items. Thus the control variables used were not considered to be valid in regard to providing differences in teacher perception of the items on problem adequacy.

Density of Concepts and Reading Difficulty

Teachers indicated that the average student had difficulty in reading the textbook Chemistry by Sienko and Plane. Jacobson*, in his study of the reading difficulty of selected textbooks, concluded that this textbook was significantly more difficult than the other textbooks he evaluated. With the exception of the items on the adequacy of problems, teacher response did not indicate a reason for their perception of reading difficulty. However, selection of content from parts of chapters and the time required by teachers in order to develop articulation among topics may have affected teacher perception of the reading difficulty of the text. If a newly authorized textbook was used as a major teaching aid and an actual reading difficulty occurred, the use of the textbook during the initial stages of implementation would be limited.

Differences at the .05 level of significance occurred in teacher perception of content density within the variable of teacher experience.

---

*cf. p. 31.

The low level of significant differences within this variable and a lack of significant differences within other variables implied that they were not acceptable for purposes of determining teacher perception to the items.

Teaching Methods

The six control variables used did not appear to be valid for purposes of stratification of teachers. Teachers ranked the lecture-demonstration-laboratory method as the most effective method of teaching. All methods which were ranked by teachers may be fruitfully used to teach chemistry, but the discussion-laboratory method may be the most effective for teaching class enquiry. The ranking of discussion-laboratory as the fifth most effective method and apparent teacher preference for more traditional modes of teaching may have been a reflection of the objectives served by the teaching of science in Alberta and of teacher familiarity with the first-ranked method.

III. CONCLUSIONS RELATED TO TEACHER PERCEPTION OF LABORATORY

Hypothesis 3: There are significantly different perceptions of the purpose of, and time to be devoted to laboratory experiences in Chemistry 30, and time to be devoted to laboratory experiences in Science 20 among categories of teachers according to laboratory availability and the control variables of training, number of university chemistry courses, subject area specialization, and years of experience.

Availability of Laboratory Related to Teacher Perception of Time to be Devoted to Laboratory Activities in Science 20 and Chemistry 30

Teacher response indicated the following:

1. Teachers perceived an increase in the time which should be devoted to laboratory activities in the future.

2. Teachers who indicated that laboratory availability was less than 21 per cent tended to be slightly more conservative in their estimate of the time which should be devoted to laboratory activities in Science 20 and Chemistry 30.

With the exception of the latter subgroup, teacher expectation of future laboratory time was affected to a greater extent by factors other than availability of facilities. Knowledge of the emphasis placed upon laboratory experiences by CHEM Study and Chemical Bond Approach chemistry may be one of the factors related to teacher perception of this item.

Purposes of Laboratory in Chemistry 30

Examination of teacher ranking of the purposes of laboratory showed:

1. Class enquiry was ranked first whereas individual enquiry was ranked last.
2. Verification of principles was ranked as equivalent to class enquiry.

Both class enquiry and individual enquiry are oriented toward inductive learning or problem solving. Although both methods involve a change in teachers' roles, teaching by the process of individual enquiry would require a greater degree of organization, provision for individual differences, and time on the part of the teachers. These factors would likely affect teacher perception of this procedure.

The reasons for the equivalent ranking of class enquiry and verification of principles were difficult to determine. Teacher

experience with verification-type laboratory exercises in high schools and knowledge of the kinds of laboratory experiences emphasized by the new physical science courses may have been factors producing an apparently contradictory response to this item. Although evidence was not present, a fundamental lack of understanding of the ranked methods may also be postulated. The problems posed by this ranking of laboratory purposes warrants further investigation of variables which may indicate differences among subgroups.

No significant differences were discovered among the subgroups' perceptions of laboratory purposes. Therefore, the hypothesis of differences was not accepted.

IV. CONCLUSIONS RELATED TO METHODS OF CURRICULUM CHANGE

Teacher perception of curricular-change was determined from response to items related to teacher experimentation with courses, use of multiple texts and teachers' guides, and the relation between a confidential teacher's mark and the final Departmental examination.

Hypothesis 4: There are significantly different perceptions of selected methods of curricular-change such as curricular-change by teachers, among categories of teachers according to the control variables.

Teacher Experimentation with New Courses or Multiple Texts in Chemistry 30 and Science 20

Teacher response to equivalent questions applied to Chemistry 30 and Science 20 was significantly different. The differences which occurred were:

1. A greater percentage of teachers perceived that experimentation with new courses or the use of multiple texts should be

allowed in Science 20 in comparison to Chemistry 30.

2. A greater percentage of teachers perceived that experimentation with courses in either Chemistry 30 or Science 20 should be allowed in comparison to the authorization of a choice of texts.

The presence of a standardized final examination essentially based upon a single text and the greater difficulty associated with the development of a course from a number of texts may have been reasons for this kind of response.

No significant differences occurred among subgroups according to the variables of years of training, ratio of physical science credits taught, and attendance at seminars. Although significant differences among subgroups existed within the variables of area of specialization and years of experience no trend was apparent to the investigator. Therefore, the variables were not considered valid for purposes of determining significant differences among subgroups of teachers.

The occurrence of significant differences at the .05 level for teachers categorized according to the number of university chemistry courses would normally be discounted. However, for all items, a straight-line relationship occurred between the number of university chemistry courses and acceptance of authorization to experiment with new courses or the use of multiple texts. An increasing percentage of teachers within subgroups indicated favorableness to experimentation as the number of university chemistry courses increased. A relationship between teacher perception of the items and stratification of teachers

according to the number of university chemistry courses was indicated. Further investigation was necessary for complete acceptance of this variable.

Use of Supplements and Teachers' Guides

A slightly greater percentage of teachers favored an annual revision of the Chemistry 30 course by means of supplements. The evidence in regard to teacher favorability to this method of change was inconclusive. The lack of significant differences among subgroups indicated that the control variables were not valid for purposes of stratification of teachers.

The control variables were not considered valid in order to determine differences in teacher perception of the inhibitory effect of teachers' guides in the first year of a new course. Significant differences occurred among subgroups within the area of specialization in regard to the inhibitory effect of continued use of teachers' guides. Teachers who did not attend seminars were significantly different from the total group of seminar attenders and teachers who attended C. P. E. T. seminars. Teachers who did not attend seminars placed more emphasis upon the inhibitory effect of continued use of teachers' guides. If the cause of the differences were other than random fluctuation, no reason was apparent to the investigator. However, the evidence indicated a need for further investigation of the characteristics of teachers who attend seminars.

The Final Mark in Chemistry 30

Teacher response favored the inclusion of the confidential mark

within a student's final mark, but did not favor the use of a teacher's mark as the sole method of evaluating a student's success in Chemistry 30. Factors which may have affected the position taken by the teachers were:

1. The problem of variation of standards among schools.
2. The difficulty of evaluating knowledge other than recall by means of a written examination.
3. The problems of pressure for subject and school success in Departmental examinations which may be applied by the community.

Examination of the response by subgroups indicated that the control variables were not related to teacher perception of the items. Teacher preference for change in the emphasis allotted to a final examination in Chemistry 30 signified a need for further investigation.

V. CONCLUSIONS RELATED TO THE PURPOSES OF CHEMISTRY REFRESHER PROGRAMS

Hypothesis 5: There are significantly different perceptions of the purpose of "refresher" programs but no significantly different perception of the need for "refresher" programs among categories of teachers according to the control variables.

Teacher response overwhelmingly favored the provision of "refresher" programs before the introduction of a new course. The hypothesis of no difference in teacher perception of the need for "refresher" programs was accepted.

Both the total group and all subgroups of teachers ranked the presentation of new concepts as the most important purpose of "refresher"

programs. The relatively large median difference between this ranking and the second-ranked purpose of acquainting teachers with laboratory work indicated an orientation towards subject-matter on the part of teachers. The relatively major change in concepts in comparison to the past chemistry course and the occurrence of change in a final year of high school chemistry may have been factors affecting teacher response. The kind of perception of purposes of a "refresher" program, as indicated by teacher response, would limit the effectiveness of programs which attempt to initiate other than content change.

Significant differences in teacher perception of the purposes of "refresher" programs occurred generally among subgroups with a small number of respondents. This factor and the lack of an observable pattern in the response of subgroups led to the rejection of the hypothesis of differences.

VI. GENERAL CONCLUSIONS

1. Teachers perceived a greater emphasis upon transitional and supplementary content within a future course.
2. The control variables did not generally appear to be valid for categorization of teachers. Each control variable appeared to contain an excessive number of factors which produced variations within the responses of subgroups.
3. Subgroups within the variables which required additional investigation were:
   a) Teachers in the area of specialization of physics-mathematics.
   b) Teachers with four or five and ten or more years of experience.

c) Teachers who had attended C. P. E. T. or two or more seminars and non-attenders.

4. Teachers perceived that the textbook presented a reading difficulty for the average students. A limitation of the text occurred within the number of drill problems and the gradation of problems.

5. Teachers perceived that authorization of experimentation with new courses or a choice of texts would be preferable in an earlier science course than Chemistry 30.

6. Evidence indicated that teachers perceived a single authorized text as preferable to a choice of authorized texts.

7. Evidence indicated a slight relationship between the number of chemistry courses in a teacher's background and his perception of experimentation with new courses or more than one authorized textbook.

8. Availability of laboratory facilities appeared to be a minor factor affecting teacher perception of time to be spent in laboratory activities. Teachers who stated laboratories were available for less than 20 per cent of the time were more conservative in their perception of time to be spent in laboratory activities in the present course but not in a future course.

9. Teacher perception of the purposes of laboratory activities indicated a conflict in the ranking. Reasons for this kind of ranking required additional investigation.

10. Teachers were overwhelmingly in favor of the use of "refresher" programs previous to the implementation of content change in

Chemistry 30. The hypothesis of no difference in teacher perception was accepted.

Teachers ranked acquaintance with new concepts as the most important purpose of a "refresher" program and ranked other purposes as virtually equivalent. The ranking indicated the orientation of teachers towards content change and the difficulty of using seminars in order to impart knowledge other than content-related knowledge.

VII. GENERAL RECOMMENDATIONS

1. Authorization of experimentation with new science courses or of a number of texts should occur in a year previous to Grade Twelve. Teachers should be made aware of the possibilities and limitations placed upon experimentation by Departmental regulations. Further, the additional time required by teachers to experiment with the development of curricula beyond the minimum stated in a curriculum guide must be recognized and considered if a teacher-experimentation approach is assumed. Provision for continuous communication among teacher-experimenters and recognition of their accomplishments are further considerations which may be made. The area of specialization and the number of courses within the teacher's background may be two of the variables to be considered in the provision of greater latitude for experimentation in content change.
2. Reading difficulty should be one of the criteria used to determine the authorization of new textbooks in Chemistry 30. The use of a single textbook in a course and evaluation of content from the textbook tends to magnify the importance of this teaching aid.

3. Consideration should be made for the provision of a resource supplement to a new text when the text appears to be limited or unsatisfactory in the kinds and numbers of problems. The supplement would allow teachers to devote less time to problem-solving and more time to familiarization with the content of the new course. In addition, through the use of items which test different levels of thinking on the part of the student, the supplement would provide guide-lines for teachers in the development of a new course.

VIII. RECOMMENDATIONS FOR FURTHER STUDY

1. The grouping of topics into traditional, transitional, and supplementary content may have concealed trends within specific topics. Further study of available data would likely indicate differences in teacher perception and expectation of change.
2. The appearance of subgroups of teachers with four or five years of experience and ten or more years of experience as significantly different from other subgroups indicates an unexpected relationship between experience and teacher perception. The lack of a straight-line relationship warrants further investigation.
3. A major problem in the study of differences in teacher perception is the broad aspect of a variable such as the number of chemistry courses within teachers' backgrounds. A presently existing need within this kind of study is the determination of variables which may be related to teacher perception of change. Examination of the groups of teachers who represented the extremes of teacher perception of content change may indicate some of the related factors.

4. The implementation of science courses which attempt to change both content and teaching methods and the use of seminars for up-dating teacher background indicates the necessity of learning further about:

   a) The characteristics of teachers who attend summer seminars.

   b) The effect of seminars upon teacher attitude towards the laboratory approach in science.

5. A need exists for investigation of the standardized examination as a mechanism for change--the effect of the examination upon teachers' perception of content change, the function of the laboratory, and readiness to change.

6. A longitudinal study of teacher perception of content at the end of the first two months and the end of the first year of implementation of a new course is needed in order to determine the effect of time upon teacher perception.

7. A need exists for the investigation of teacher attitudes and feelings of adequacy towards laboratory activities in science and the importance attributed to the laboratory relative to other methods of teaching science.

8. A need exists for the investigation of the problem of communication which exists between agents of change and the recipients of change.

9. A need exists for the investigation of teacher perception of curriculum change and classroom performance of selected teacher groups. The study may reveal a different pattern of teacher perception.

LIST OF REFERENCES

LIST OF REFERENCES

1. Alberta Department of Education, Early Warning Announcement Regarding Science 10 for September 1960,(Edmonton, Department of Education, Province of Alberta, 1960), p. 2.

2. Alberta Teachers' Association Professional Load Committee, The Professional Load of Alberta Teachers, Research Monograph IV, (Edmonton, Alberta Teachers' Association, 1963), p. 79.

3. Allen, W. F. and S. G. Davis, Chemistry 30 Supplement, (Edmonton: Department of Chemistry, University of Alberta, 1963).

4. Anderson, Kenneth E. et al, "Second Annual Review of Research in Science Teaching", Science Education, XXXVIII (December, 1954), p. 346.

5. Brickell, Henry W., "The Dynamics of Educational Change", Theory Into Practice, I, No. 2, (April, 1962), p. 84.

6. Burnett, Will R., Review of Educational Research, XXXIV, No. 3, (June, 1964), p. 319.

7. Ibid., p. 320.

8. Bushnell, Margaret, "Now We're Lagging Only 20 Years", School Executive LXXVII (October, 1957), p. 63.

9. Campbell, Roald F. and Robert A. Bunnell, "Differential Impact of National Programs on Secondary Schools", School Review, LXXI (Winter, 1963), p. 476.

10. Canadian Education Association, The, Convention Proceedings and Addresses, (Quebec City, Quebec, 1963), pp. 45-47.

11. Carleton, Robert H., "Improving Secondary School Science", Rethinking Science Education, Fifty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago, Ill.: University of Chicago Press, 1960), p. 162.

12. Chase, Francis S., "Some Effects of Current Curriculum Projects on Educational Policy and Practice", School Review, LXX (No. 1, 1962), p. 134.

13. Ibid., p. 135.

14. Conant, James B., On Understanding Science, (New York, New American Library, 1951), p. 19.

15. Dempsey, Richard Allen, "An Analysis of Teachers' Expressed Judgments of Barriers to Curriculum Changes in Relation to the Factor of Individual Readiness to Change", Dissertation Abstracts, XXIV (February, 1964), p. 3225.

16. Edwards, Allen L., Statistical Methods for the Behavioral Sciences, (New York: Rinehart and Company, Inc., 1958), p. 46.

17. Eichholtz, Gerhard, C., "Development of a Rejection Clasification for Newer Media", Dissertation Abstracts, XXII, No. 2, (August, 1961), p. 501.

18. Friedrich, Benjamin C., "An Analysis of High School Chemistry Teachers' Attitudes Toward and Emphasis on Certain Contemporary Topics in Chemistry", (Unpublished D. Ed. Dissertation, Pennsylvania State University, 1961), p. 141.

19. Fitzpatrick, Frederick L. (ed.), Modern High School Chemistry - A Recommended Course of Studies, The Science Manpower Project, (New York: Teachers College, Columbia University, 1960), p. vii.

20. Gilchrist, Robert S., "Innovations in the High School Curriculum", The High School in a New Era, edited by F. S. Chase and H. A. Anderson, (Chicago, Ill.: University of Chicago Press, 1958), p. 208.

21. Gruber, Howard E., "Science as Doctrine or Thought? A Critical Study of Nine Academic Year Institutes", Journal of Research in Science Teaching, I, No. 2, (June, 1963), p. 126.

22. Harriman, Vernon J., "The Inclusion of Modern Chemistry in Current Secondary School Chemistry Textbooks", (Unpublished Ed. D. dissertation, University of Missouri, 1966), p. 9.

23. Ibid., p. 107.

24. "Head of the Class, The", Time, October 15, 1965, p. 72.

25. Heusner, Henry C., "A Study of Curriculum Guides as Related to Selected Factors in Planning and Construction", Dissertation Abstracts, XXV, No. 1, (July, 1964), p. 322.

26. Houston, Walter S., "Information Retrieval", Science and Math Weekly - Teachers' Edition, V (October 14, 1964), p. 1.

27. Hughes, Walter L., "History of Physical Science in Alberta", (Unpublished Master's Thesis, University of Alberta, 1964), p.ii.

28. Ibid., p. 132.

29. Ibid., p. 143.

30. Ibid., pp. 143-4.

31. Hurd, Paul DeH., "Science Education for Changing Times", Rethinking Science Education, Fifty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago, Ill.: University of Chicago Press, 1960), p. 33.

32. _____. "Science Literacy: Its Meaning for American Schools", Educational Leadership, XVI (October, 1958), p. 14.

33. Hurd, Paul DeH. and Budd M. Rowe, Review of Educational Research, XXXIV, No. 3, (June, 1964), p. 292.

34. Hutchinson, John S., "Examine the Dynamics of Change", School Science and Mathematics, LXIV, No. 6, (June, 1964), p. 553.

35. Jacobson, Milton D., "Reading Difficulty of Physics and Chemistry Textbooks in Use in Minnesota", (Unpublished Ph. D. dissertation, University of Minnesota, 1961), p. 79.

36. Kelley, Gaylen B., "A Study of Teachers' Attitudes Towards Audio-visual Materials", Educational Screen and Audiovisual Guide, XXXIX, No. 3, (March, 1960), p. 121.

37. Keppel, Francis, "The Impact of Educational Technology", Excerpts from A. M. A. Address - American Management Association Conference, N. Y., quoted in Scholastic Teacher - Edition of Scholastic Sciences, XVIII, (October 14, 1965), p. 14.

38. Kniseley, V. V., "Inevitable Obsolescence", Theory Into Practice, III, No. 1, (February, 1964), p. 32.

39. Laboratory Exercises in Chemistry 30, (Edmonton: School Book Branch, Department of Education).

40. Laux, Dean M., "A New Role for Teachers", Phi Delta Kappan, XLVI (February, 1965), p. 267.

41. Lerner, Morris, "Integrated Science", Science Teacher, XXXI (February, 1964), p. 37.

42. Lippitt, Ronald, Jeanne Watson and Bruce Westley, The Dynamics of Planned Change, (New York: Harcourt, Brace and Company, 1958), p. 10.

43. MacKenzie, G. N., "The Social Context of Curriculum Change", Theory into Practice, I (October, 1962), p. 189.

44. Mayor, John R., "Some Issues in Science Education", Phi Delta Kappan, XXXIX (February, 1958), p. 219.

45. Merrill, Richard J., "CHEM Study - Implications for the School Counsellor", Chemical Education Study Newsletter, IV (May, 1964), p. 10.

46. Miel, Alice, Changing the Curriculum, (New York: Appleton-Century Company Inc., 1946), p. 41.

47. Miles, Matthew B., Innovations in Education, (New York: Bureau of Publications, Teachers College, Columbia University, 1964), p. 10.

48. Ibid., pp. 19-20.

49. Mort, Paul R., "The Adaptability Studies and the Marshalling of Human Resources", School Executive, LXXI, No. 9, (May, 1952), p. 71.

50. Obourne, Ellsworth S. and Claude W. Gatewood, "Improving Science Education in the United States", Journal of Research in Science Teaching, I (December, 1963), p. 396.

51. Oppenheimer, Robert, "Prospects in the Arts and Sciences", The Open Mind, (New York: Simon and Schuster, 1955), p. 141.

52. Orr, David B. and Albert T. Young Jr., "Who Attends N. S. F. Institutes", The Science Teacher, XXX, No. 7, (November, 1963), p. 40.

53. Riecker, Henry W. (ed.), Science Course Improvement Projects, (Washington, U.S. Government Printing Office, 1964), p. iii.

54. Scott, Arthur F., "Putting Chemistry in Education", Chemical and Engineering News, XLIII (March 29, 1965), p. 83.

55. Ibid., pp. 86-7.

56. Seaborg, Glenn, "New Concepts in Chemical Education", Chemical and Engineering News, XXXVIII (October 17, 1960), p. 97.

57. Ibid., p. 98.

58. Showalter, Victor, "Unified Science, An Alternative to Tradition", Science Teacher, XXXI (February, 1964), p. 24.

59. Siegel, Sidney, Nonparametric Statistics for the Behavioral Sciences, (New York: McGraw-Hill Book Company, Inc., 1956), p. 9.

60. Ibid., pp. 18-19.

61. Ibid., pp. 22-26.

62. Ibid., p. 204.

63. Stanhope, Roy W., "Four Years of School Science for All", The Science Teacher, XXXI (February, 1964), p. 24.

64. Thurber, Walter A. and Alfred T. Collette, Teaching Science in Today's Secondary Schools: Second Edition, (Boston: Allyn and Bacon Inc., 1964), pp. 239-242.

65. Ibid., pp. 236-37.

66. Trieger, Seymour, "Education and Knowledge Explosion", SCAT Bulletin, I (June, 1962), p. 1.

67. Tyler, Ralph W., "Forces Redirecting Science Teaching", The Science Teacher, XXIX (october, 1962), p. 24.

68. Ibid.

69. Van Til, William, "In a Climate of Change", Role of the Supervisor and Curriculum Director in a Climate of Change, Yearbook ASCD, (Washington, D. C., 1965), p. 23.

70. Watts, M. L., "Change Factors and Trends in High Schools", Educational Change Problems and Prospects, (Edmonton: The Department of Secondary Education, The University of Alberta, 1964), pp. 45-6 (mimeo).

71. Williams, Henry H., Science Education in American Schools, Forty-sixth Yearbook of the National Society for the Study of Education, Part I, (Chicago, Ill.: University of Chicago Press, 1947), pp. 202-03.

APPENDIX A

"A LONGITUDINAL STUDY OF
PROBLEMS IN THE INTRODUCTION
OF A NEW CHEMISTRY 30 COURSE"

PHASE I

This questionnaire is divided into three parts. The parts are:

I. General information
II. Curriculum Change
III. The Laboratory and Areas Related to Change

Instructions precede each part of the questionnaire. If you wish results of this research, check here._____.

A. General Information

1. The grade organization of your school is:

Grade 1 - 12 _____, 7 - 12_____, 10 - 12_____, Other_____

2. The size of the school in which you are teaching is:

less than 8 rooms_____, 8 - 15 rooms_____, 16 - 23 rooms_____,

24 - 31 rooms_____, more than 31 rooms_____.

3, The number of teachers who are teaching Chemistry 30 in your school are:

1_____, 2_____, 3 or more_____

4. (a) The number of years of University training you have at present are: less than 3_____, 3_____, 4_____, 5 or more_____

(b) The University Degree(s) held are_____

(c) The number of Chemistry courses completed at University are:

_____

(d) The last University course in Chemistry was completed in 19___.

5. The subject area(s) in which you specialized at University was: (Using the numbers 1, 2, 3,...please indicate the order of specialization. Use the number "1" for your major field of study. Leave blank those fields in which no courses were obtained.)

Chemistry _____
Geology _____
Botany _____
Physics _____
Mathematics _____
Zoology _____
Other (list course) _____

6. The number of years you have taught Chemistry 30 are:

0-1_____, 2-3_____, 4-5_____, 6-7_____,

8-9_____, 10 or more_____.

7.(a) The number of credits taught by you this year are_____.

(b) Please list all courses and the number of classes of each course taught by you this year:

Course	Number of Classes	Course	Number of Classes

8. Are you exchanging ideas with one or more teachers either in your system or other systems on means of effectively presenting the new Chemistry 30 course?

No_____Seldon_____Occasionally_____Regularly_____

9.(a) The University of Alberta sponsored Chemistry 330 in the summer of 1963. The University through its program Continuing Proffessional Education for Teachers (C.P.E.T.), and the Science Council of the Alberta Teachers' Association, also sponsored the seminar in 1964. If you were able to attend, check the activity(ies) attended:

Chemistry 330_____C.P.E.T._____Science Council Summer Seminar (1964)_____

(b) If you were able to attend in-service week-end Seminars, check the following:

In-Service Seminars 1962_____, 1963_____, 1964_____

1965_____

Total number of In-Service Seminars attended were _____

10.(a) When did you become aware that changes in Chemistry 30 would occur? 1962_____, 1963_____, Spring of 1964_____

How were you made aware?

Official Notice _____unofficial (word of mouth) _____

uncertain _____

11. Your laboratory is available for each of your Chemistry 30 classes (Answer one only):

(i) Whenever you require its use for ____ periods per week, _____minutes long,

OR

(ii) Through scheduling for _____periods per week _____ minutes long.

Other _____

12(a) The ability(ies) of the Chemistry 30 classes taught by you are rated as:

Ability	Number of Classes	Number of Students
Above average	_____	_____
Average	_____	_____
Below average	_____	_____

(b) The classes are grouped by ability

Yes_____, No_____

(c) Students repeating Chemistry 30 represent _____% of your classes.

II. CURRICULUM CHANGE:

Part II attempts to explore the area of curriculum change. The four areas included in Part II are:

Section A Evaluation of the old and new Chemistry 30 courses.

Section B Prediction of trends and emphasis in content.

Section C Adequacy of the parts of the new text used in Chemistry 30.

Section D Evaluation of student difficulties.

The four sections are placed into two matrices. The first matrix contains Sections A and B while the second matrix contains Sections C and D. The four Sections are arranged into columns which may be answered by the use of check marks ( ). Each Section should be answered separately according to vertical columns. PLEASE FILL IN ONE SECTION AT A TIME. Detailed information on each Section will be found before each matrix.

SECTION A.

Would you please make a comparison of the emphasis placed on selected topics in the previous Chemistry 30 course (text by Croal et al) and the present Chemistry 30 course (text by Sienko and Plane). The previous course is labelled "old" and the present Chemistry course is labelled "new" at the top of each column. If this is your first year of teaching Chemistry 30 would you rate only the present course. Please rate the courses by checking the correct column according to the following scale:

"The course gives insufficient emphasis to the topic"

"The course gives adequate emphasis to the topic"

"The course gives excessive emphasis to the topic"

SECTION B

Would you make a prediction in regard to the future of Chemistry 30. If you believe that a topic:

"Will have less emphasis within the next five years."

"Will have equal emphasis within the nest five years."

"Will have more emphasis within the next five years".

	(A) Emphasis						(B) Future		
	old			new					
	too little	ade-quate	too much	too little	ade-quate	too much	less	equal	more
Chemistry of the Elements									
Organic									
Chemical Technology									
Chemical calculations									
Atomic Structure (Bohr Atom)									
Atomic Structure (orbitals)									
Bonding (Bohr Atom)									
Orbital Overlap (σ and π Bonds)									
Hybridization of Orbitals									
Delocalized Electrons									
Molecular Structure									
Crystal Formation									
Solutions									
Oxidation-reduction									
Electochemistry									
Acids and bases									
Kinetic-Molecular Theory									
Scientific methods									

SECTION C

Would you rate the text "Chemistry" by Sienko and Plane in terms of the adequacy with which it develops the topic, according to the following:

"The text develops the topic inadequately".

"The text develops the topic adequately".

"The text develops the topic with excessive information".

SECTION D

This Section asks you to rate the difficulty of the topics for the students. Please rate the topics according to the following:

"Students had little difficulty with the topic."

"Students had average difficulty with the topic".

"Students had great difficulty with the topic".

	(C) Text			(D) Student		
	inad.	ad.	excess	little	av.	great.
Chemistry of the Elements						
Organic						
Chemical Technology						
Chemical calculations						
Atomic Structure (Bohr Atom)						
Atomic Structure (orbitals)						
Bonding (Bohr Atom)						
Orbital Overlap (σ and π Bonds)						
Hybridization of Orbitals						
DelocalizedElectrons						
Molecular Structure						
Crystal Formation						
Solutions						
Oxidation-reduction						
Electrochemistry						
Acids and bases						
Kinetic-Molecular Theory						
Scientific methods						

1. If time permitted expansion of the course, please list two or more topics whichwere not included in the matrix but which you feel should be included in a new Chemistry 30 course.

1. _____ 4. _____

2. _____ 5. _____

3. _____

The Text.

Some of the following questions are open-ended in order to allow you to add further information if you so wish.

2. The number of line cuts (figures, tables, graphs) used in the text was: Excessive____ Adequate_____ Inadequate___

_____

_____

3. (a) The scientific terms are adequately defined in the textbook. Yes_____ No._____ Undecided____

Comment_____

(b) The non-scientific vocabulary is too difficult (e.g. deflection) Yes_____ No._____ Undecided____

Comment _____

_____

4. The average student has little difficulty in reading this text. Yes_____ No._____ Undecided____

_____

_____

5. (a) Questions and/or problems at the end of the chapters are graded explicitly in difficulty. Yes_____ No _____ Undecided____

_____

_____

(b) The problems provided at the end of the chapters are thought provoking to the average student. Yes_____ No _____ Undecided____

_____

(c) The number of problems provided for drill on a particular concept is adequate.

Yes_____

No_____

Undecided____

_____

_____

6. (a) The number of concepts introduced within the text in each Section is:

Excessive_____

Adequate_____

Inadequate_____

Undecided_____

_____

_____

(b) The number of concepts introduced within the text in each chapter is:

Excessive_____

Adequate_____

Inadequate_____

Undecided_____

_____

_____

III The Laboratory and Areas Related to Change.

Part III attempts to explore two areas. One area relates to methods of instruction and the other to the mechanics of curriculum change. Most questions may be answered by checking(✓) the answer you believe to be appropriate. Most questions are open-ended in order to allow you to add comments if you wish.

A. Methods of Instruction.

1.(a) From the viewpoint of available facilities in your school,the time spent in the laboratory in Chemistry 30 could be _____%.

(b) Under ideal conditions, the percentage of time spent in the laboratory by students in Chemistry 30 in the year 1965-6 should be (Circle ONE)

0 10 20 30 40 50 60 70 80 90 100

(c) Under ideal conditions, the percentage of time spent in the laboratory by students in Chemistry 30 in the year 1970 should be (Circle ONE)

0 10 20 30 40 50 60 70 80 90 100

2.(a) From the viewpoint of available facilities in your school the time spent in the laboratory in Science 20 could be_____%.

(b) Under ideal conditions, the percentage of time spent in the laboratory by students in the year 1965-6 should be: (Circle ONE)

0 10 20 30 40 50 60 70 80 90 100

(c) Under ideal conditions, the percen tage of time spent in the laboratory by Students in Science 20 in the year 1970 should be: (Circle ONE)

0 10 20 30 40 50 60 70 80 90 100

3. The purpose of laboratory work in a modern Chemistry 30 course should be: (Rate in order of importance. The number "1" is most important)

development of techniques_____enquiry (investigation of a problem by a class)_____ verification and illustration of principles_____ qualitative and quanititative analysis_____, enquiry (investigation by individuals of individual problems)_____

other_____

4.(a) Laboratory work and classroom work should have no correlation_____ slight correlation_____ high correlation_____

(b) Laboratory work generally should precede_____should not precede_____classroom work. Both possibilities may receive about equal emphasis,_____.

_____

_____

5. The teaching method or combination of teaching methods most effective in Chemistry 30 is: (Rate in order of importance. The number "1" is most important)

Lecture_____ Discussion-demonstration_____ lecture demonstration_____ demonstration-laboratory_____ lecture-demonstration-laboratory _____ discussion_____ discussion-laboratory_____, other_____

_____

_____

6. Teaching aids which may be used effectively in teaching Chemistry 30 are: (Rate in order of effectiveness. The number "1" is most effective).

models_____ charts_____ films_____ filmstrips_____ overhead projector_____ other_____

_____

_____

B. Mechanics of Curriculum Change:

1.(a) In Chemistry 30, a teacher should be allowed to choose among authorized texts rather than a prescribed text. Yes_____ No_____ Undecided___

(b) In Science 20, a teacher should be allowed to choose among authorized texts rather than a prescribed text. Yes_____ No_____ Undecided___

2.(a) A new course in Chemistry 30 should be introduced into schools on an optional basis_____, a compulsory basis_____.

(b) If optional, the time limit should be:

1_____, 2_____, 3_____, 4_____, 5_____, 6 or more years_____

_____

_____

(c) The option of teaching a new course should be decided by:

the individual chemistry teacher or teachers in the school_____

all chemistry teachers in the school_____, chemistry teachers and administrative personnel in the school_____administrative personnel in the system in consultation only with chemistry teachers_____a group decision of administrative personnel and chemistry teachers in the system_____

other_____

3. (a) A detailed Teacher's Course Guide may inhibit the presentation of a new course in the first year, — Yes_____ No_____ Undecided_____

(b) A detailed Teacher's Course Guide may inhibit the presentation of a new course in later years. — Yes_____ No_____ Undecided_____

_____

_____

4. The Chemistry 30 course should be reviesed annually by means of using Supplements to the new course. — Yes_____ No_____ Undecided_____

_____

_____

5. (a) Before the introduction of a new Chemistry course, a "refresher" program for teachers should be provided. — Yes_____ No_____ Undecided_____

_____

_____

(b) The purpose of this "Refresher" program should be: (Rate in order of importance. The number "1" is most important). acquaint the teacher with the laboratory work of the new course_____, acquaint the teacher with teaching methodolgy of the new course_____, acquaint the teacher with the philosophy of the new course_____, acquaint the teacher with the concepts of the new course_____

_____

_____

(c) What kind of aid on a continuing or regular basis would be most useful to Chemistry teaching?

_____

_____

6. (a) Teachers should be allowed to experiment with <u>or</u> develop courses in Chemistry 30.

Yes_____
No_____
Undecided____

(b) Teachers should be allowed to experiment with <u>or</u> develop courses in Science 20

Yes_____
No_____
Undecided____

_____

_____

7. (a) The Teacher's confidential mark for a student in Chemsitry 30 should be a portion of the final mark received by the student.

Yes_____
No_____
Undecided_____

_____

_____

(b) Should the final mark in Chemistry 30 be determined by the Chemistry teacher?

Yes_____
No_____
Undecided_____

_____

_____

Comments.

DISTRIBUTION OF TEACHERS WHO RECEIVED THE QUESTIONNAIRE FOR PRETESTING

Lacombe

Alix	1
Bentley	1
Clive	1
Lacombe	1
Mirror	1

Sturgeon

Bon Accord	1
Camilla	1
Horse Hill	1
Legal	1
Namao	1

Medicine Hat City

Crescent Heights	1
McCoy High	1
Medicine Hat High	1

Edmonton

H. E. Marcellus
W. Moysa
L. Geake
R. A. Poulin

Edson

Edson Senior High	1
Evansburg	1
Hinton	1
Niton	1

Taber

Grassy Lake	1
W. R. Myers (Taber)	1
St. Mary's (Taber)	1
Vauxhall	1

Grande Prairie

Beaverlodge (Grande Prairie)	1
Berwyn (Peace River)	1
Girouxville (High Prairie)	1
Grande Prairie High	1
T. A. Norris (Peace River)	1

Calgary

Rev. W. Kelly
Miss A. Condon
G. E. Millar
R. W. Robinson

SAMPLE LETTER TO SUPERINTENDENTS OF SCHOOLS

May 11, 1965.

Dear

I am presently working on a Master's Thesis at the University of Alberta. The topic of the Thesis is "Problems in the Introduction of a New Course in Chemistry 30". The major instrument used in the study is a questionnaire. The present questionnaire was revised after being pre-tested in April. I hope to send the revised questionnaire to all Chemistry teachers in Alberta on May 22nd.

May I obtain your permission to submit the questionnaire to the Chemistry teachers in your area. My intent is to send the questionnaire through the Principal's office, or through your office if you would prefer this arrangement.

May I thank you at this time for any consideration you may be able to give.

Yours truly,

W. Soprovich,
Principal,
St. Albert High School.

SAMPLE LETTER TO PRINCIPAL OF SCHOOL FOR
PRETEST OF THE QUESTIONNAIRE

St. Albert, Alberta,

April 5th, 1965.

Dear

Enclosed is a covering letter, questionnaire and return envelopes for a Chemistry 30 teacher on your staff. This research attempts to study the topic, "Problems in the Introduction of a New Chemistry 30 Course". I respectfully request that you aid my research by passing this material to your Chemistry 30 teacher <u>or</u> if more than one Chemistry 30 teacher is involved, the particular teacher indicated in the letter.

I have previously written the Superintendent of Schools and have obtained permission to contact you. May I thank you at this time for any aid you may be able to give me in this survey.

Yours truly,

W. Soprovich.

SAMPLE LETTER TO TEACHER IN THE PRETEST GROUP

St. Albert, Alberta,
April 5th, 1965.

Dear

Today's educational literature implies that one of the dimensions involved in Science teaching will be rapidly changing curricula. You are well aware of the recent change in Chemistry 30. If this is to be the scene in science education, it would appear that a study of the problems related to change in curriculum may be of some value. This is essntially the purpose of this research.

The research design involves the use of a questionnaire. In order to pre-test this questionnaire, it is being sent to Chemistry 30 teachers in selected areas of Alberta. I realize that you are busy at this time of the year; however, your thoughtful completion of the questionnaire is most important to this research. I would further request that you circle in red <u>any ambiguously-worded questions</u> and <u>add any comments</u> you may deem helpful. An area is provided for comments and is to be found at the end of the questionnaire. In order to complete the field work before the end of June, I respectfully request that the present questionnaire be completed and in the mail by April 17th.

In order to provide anonymity to your questionnaire, two return envelopes are provided. Your completed questionnaire may be placed in the plain envelope which in turn may be placed in the stamped, self-addressed envlope.

Upon receipt of your envelope with its completed questionnaire, the envelope with the questionnaire will be placed randomly into a pile of returned questionnaires. All returned questionnaires will be opened at the same time.

If you are interested in the results of this survey, I will provide them when the research is completed. I will be looking forward with interest to receiving the completed questionnaire.

Yours truly,

W. Soprovich

SAMPLE LETTER TO CHEMISTRY 30 TEACHERS

17 Balmoral Drive,
St. Albert, Alberta,
May 17, 1965.

Dear Sir:

Today's educational literature implies that one of the dimensions involved in Science teaching will be rapidly changing curricula. You are well aware of the recent change in Chemistry 30. If this is to be the scene in science education, it would appear that a study of the problems related to change in curriculum may be of some value. This is essentially the purpose of this research.

The research design involves the use of a questionnaire. I realize that you are busy at this time of the year; however, your thoughtful completion of the questionnaire is most important to this research. In order to complete the field work before the end of June, I respectfully request that the present questionnaire be completed and in the mail by June 4th.

In order to provide anonymity to your questionnaire, two return envelopes are provided. Your completed questionnaire may be placed in the plain envelope which in turn may be placed in the stamped, self-addressed envelope.

Upon receipt of your envelope with its completed questionnaire, the envelope with the questionnaire will be placed randomly into a pile of returned questionnaires. All returned questionnaires will be opened at the same time.

If you are interested in the results of this survey, I will provide them when the research is completed. I will be looking forward with interest to receiving the completed questionnaire.

Yours truly,

W. Soprovich

SAMPLE REMINDER LETTER TO CHEMISTRY 30 TEACHERS

17 Balmoral Drive,
St. Albert, Alberta,
June 7th, 1965.

Dear

The questionnaire on "Some Problems in the Introduction of a new Course in Chemistry 30" was sent to Three Hundred and Thirty-Five teachers in the province. In view of the fact that this is a busy time of year for teachers, the response to date has been excellent.

In order to ensure as complete data as possible and because of the provision for anonymity, I must send a letter of reminder to all Chemistry 30 teachers who have received a questionnaire. Thus, if you have returned the questionnaire, kindly ignore this reminder. May I take this opportunity to thank you again for your help.

Yours truly,

W. Soprovich

P.S. If the questionnaire was lost in transit or misplaced, I would be happy to send another questionnaire and stamped self-addressed envlope. Kindly check here_____and return this letter to me.

SAMPLE REMINDER LETTER TO CHEMISTRY 30 TEACHERS

17 Balmoral Drive,
St. Albert, Alberta,
June 24th, 1965.

Dear

The questionnaire on Chemistry 30 was sent in May to 335 teachers in the province. To date 61% of the teachers who received questionnaires have submitted the completed questionnaire. I would like to thank teachers who have made the time to complete the survey. I realize that school closing and final examinations leave little time for other projects.

In order to obtain a more complete data, I would appreciate receiving completed questionnaires from Chemistry teachers until July 6th. If you have returned the questionnaire, kindly ignore this reminder.

Yours truly,

W. Soprovich

P.S. If the questionnaire was lost in transit or misplaced, I would be happy to send another questionnaire and stamped self-addressed envelope. Kindly check here_____and return this letter to me with your name and address.

APPENDIX B

COMPARISON OF EMPHASIS PLACED UPON TOPICS BY THE TEXTBOOKS USED IN THE CHEMISTRY PROGRAMS

The textbook Chemistry for Secondary Schools (Advanced Edition) by Croale et al was used in Alberta schools from September 1955 to June 1964 inclusive. The textbook Chemistry by Sienko and Plane replaced the previous textbook in September of 1964. A comparison of the textbooks was made according to the following criteria:

1. The average number of words per page was calculated for each textbook. The first page of the textbook as used in the Chemistry 30 course was counted. Every tenth page beyond the first was counted until a total word count for five pages was calculated. Exceptions to this procedure occurred when the page to be counted was either a partial page or a page containing questions only. In this case the following tenth page which contained new content was counted.
2. A count was made of the number of pages each textbook devoted to the topics listed in the questionnaire. A page containing tables or figures and textual content was considered equivalent to a page containing text only.

Although limited in ability to discriminate where differences are small, the criteria provided a basis for indicating the emphasis placed upon topics by the textbooks.

The average number of words per page in the textbooks Chemistry for Secondary Schools (Advanced Edition) and Chemistry were 259 and 329 respectively. Although the number of pages counted was limited, examina-

tion of the two textbooks indicated the use of a greater number of figures and tables in the former textbook. This factor partially accounted for the difference between the word counts.

The number of pages devoted to each topic is shown in Table XXXIII. The topics were grouped into two categories. If the former textbook Chemistry for Secondary Schools (Advanced Edition) contained 30 per cent more pages devoted to a topic than the present Chemistry 30 textbook, the topic was categorized as traditional content. If the textbook Chemistry contained an equivalent or an increase in the number of pages devoted to the topic, the topic was categorized as transitional content.

The number of pages devoted to a topic by the two textbooks was assumed to be an indication of the emphasis placed upon the topics by the textbook and Program of Studies. The grouping of topics provided a basis whereby teacher perception of content change could be compared. Supplementary content, a third category, was added to the two groups of topics. Orbital overlap (σ and π bonds), hybridization of orbitals and delocalized electrons as aspects of the quantum theory were included in the category of supplementary content. Although the subjects were not a portion of the textbooks or the Program of Studies, all subjects could be used by teachers in the development of molecular bonding and the shapes of molecules.

TABLE XXXIII

NUMBER OF PAGES PER TOPIC IN THE TEXTBOOKS CHEMISTRY FOR SECONDARY SCHOOLS AND CHEMISTRY

Traditional Content

	Chemistry for Secondary Schools	Chemistry
Chemistry of elements (elements, compounds, uses, properties)	70	25
Chemical technology (processes of extraction, applications of principles)	33	3
Atomic structure and bonding (Bohr atom)	10	5

TABLE XXXIII (continued)

Transitional Content

Organic (carbon and carbon compounds)	29	28
Acids and bases	7	6
Chemical calculations (stoichiometry, quantitative chemistry)	28	36
Oxidation-reduction	6	16
Scientific methods (description of methods)	5	13
Kinetic-energy molecular theory	7	22
Solutions	2	11
Electrochemistry	2	20
Crystal formation	0	3
Atomic structure (orbital theory)	0	16
Molecular structure (orbital theory)	0	5

APPENDIX C

TABLE XXXIV

TEACHER RESPONSE TO SCHOOL ORGANIZATION

	1 - 12	7 - 12	10 - 12	Other
The grade organization of your school is	127	36	58	27

TABLE XXXV

TEACHER RESPONSE TO SIZE OF SCHOOL

	Less than 8 rooms	8 - 15 rooms	16 - 23 rooms	24 - 31 rooms	More than 31 rooms
The size of the school in which you are teaching is	13	127	60	12	36

TABLE XXXVI

NUMBER OF CHEMISTRY 30 TEACHERS IN A SCHOOL

	One	Two	Three or more
The number of teachers of Chemistry 30 per school is	208	21	19

TABLE XXXVII

RECENCY OF LAST UNIVERSITY CHEMISTRY COURSE

	Pre-1946	1946-1950	1951-1955	1956-1960	1961-1965
The last university course was completed	27	28	21	56	91

TABLE XXXVIII

TEACHER RESPONSE TO TOPICS ACCORDING TO ADEQUACY OF TEXT AND DIFFICULTY FOR STUDENTS

	Text			Student		
	Inade-quate	Ade-quate	Excess	Little	Aver-age	Great
Chemistry of the elements	35	161	44	45	122	43
Organic	110	127	8	45	138	43
Chemical technology	72	158	6	38	121	37
Chemical calculations	46	170	23	13	75	132
Atomic structure (Bohr atom)	59	171	7	83	94	24
Atomic structure (orbitals)	99	141	4	23	128	66
Bonding (Bohr atom)	79	153	6	43	112	54
Orbital overlap (σ and π bonds)	189	39	6	8	55	141
Hybridization of orbitals	191	44	5	5	69	139
Delocalized electrons	132	81	4	8	87	88
Molecular structure	74	166	1	19	144	48
Crystal formation	61	173	7	13	143	51
Solutions	25	212	3	20	137	53
Oxidation-reduction	7	220	17	28	119	72
Electrochemistry	15	202	25	8	88	123
Acids and bases	61	176	7	32	154	28
Kinetic-molecular theory	39	199	5	28	143	41
Scientific methods	97	136	2	34	144	19

TABLE XXXIX

TEACHER EXCHANGE OF IDEAS ON MEANS OF EFFECTIVELY PRESENTING THE NEW CHEMISTRY 30 COURSE

	No	Seldom	Occas-ionally	Regularly
Are you exchanging ideas with one or more teachers?	17	49	132	50

TABLE XL

TEACHER AWARENESS OF IMPENDING CHANGE IN CHEMISTRY 30

	1962	1963	Spring of 1964
When did you first become aware that changes in Chemistry 30 would occur?	47	0	101

	Official Notice	Unofficial (word of mouth)	Uncertain
How were you made aware?	76	118	41

TABLE XLI

TEACHER PERCEPTION OF A TIME LIMIT ON THE OPTIONAL INTRODUCTION OF CHEMISTRY 30

	Non-Respon-dents	One Year	Two Years	Three Years	Four Years	Five Years	Six or more Years
If optional, the time limit should be	137	12	41	44	9	5	0

TABLE XLII

TEACHER PERCEPTION OF EFFECTIVENESS OF TEACHING AIDS FOR CHEMISTRY 30

Teaching Aid	Number of Respondents	Non-respondents	Rank Order	Median
Models	233	15	1	1.38
Charts	225	23	2	2.75
Films	206	42	2	2.75
Overhead Projector	182	66	4	3.47
Filmstrips	194	54	5	3.80

TABLE XLIII

TEACHER PERCEPTION OF LABORATORY CORRELATION WITH CLASSROOM ACTIVITIES

	No Correlation	Slight Correlation	High Correlation
Laboratory work and classroom work should have	2	4	238

	Precede	Not Precede	Both Possibilities
Laboratory work generally should_____classroom work	41	56	143

TABLE XLIV

TEACHER PERCEPTION OF WHO SHOULD DECIDE UPON THE OPTION OF INTRODUCING A NEW CHEMISTRY 30 COURSE

	Number of Respondents
The individual chemistry teacher or teachers in the school	13
Chemistry teachers and administrative personnel in the school	60
Administration personnel in the system in consultation only with chemistry teachers	17
All chemistry teachers in the school	17
A group decision of administrative personnel and chemistry teachers in the system	114